FIELD STUDIES OF GUATEMALAN MAIZE[1]

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The variation pattern of *Zea Mays* is surprisingly like that of man It is made up of a number of poorly defined geographical races and sub-races, some of which characterize wide areas while others are of restricted distribution. The members of any one population vary greatly one from another, and ordinarily it is only by statistical methods that one can demonstrate regional differences.

In maize, as in man, there are centers of variation in which strikingly different forms are found in a comparatively small area. For the maize plant one of these centers is western Guatemala where, according to Mangelsdorf and Cameron (1942) "in an area less than half the size of the state of Iowa are found probably more distinct types of corn than occur in the entire United States." This great variability of Guatemalan maize has attracted numerous collectors and is one of the reasons why Iowa State College recently established a Tropical Research Center in Antigua, Guatemala. However, judgments with regard to the comparative variability of Latin American maize need to be made with greater caution than they have been in the past. Most of the corn in the United States corn belt is uniform in color. Much Latin American corn has not been so rigidly selected for that feature and to our eyes looks more conspicuously variable than it really is. As every geneticist knows, a few segregating color genes can give the impression of great variability to a population which is relatively uniform morphologically. As we shall demonstrate below, Guatemalan fields are, morphologically, among the most uniform which have yet been studied, though there is indeed a great variation between different varieties.

Unfortunately, most of the collections of maize from Guatemala are of separate ears bought in the market or obtained at agricultural exhibitions, or bought from farmers. Maize, however, is a cross-pollinated plant and single ears are therefore not as significant as in some other crops. In wheat, which is almost continuously self-pollinated, a single spike, if well chosen, may be an efficient representative of that variety. In maize (extremely heterozygous and nearly always cross-pollinated under natural conditions) a single individual is somewhat of an accident. Out of all the millions of gene combinations which might have occurred in a particular field any single ear is one of the relatively few gene combinations which did come into existence. Unless carefully chosen it is not an efficient reflection of the gene frequencies in the field where it was grown. Were it selected to be representative it might have more significance but, as Cutler (1946) has recently shown, the very

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reverse usually takes place: it is the unrepresentative ear which is odd-looking and gets the attention of the collector. Cutler has actual statistics on this point and they are impressive (loc. cit., p. 261):

> In the case of maize, colored or freak ears frequently receive more attention than normal ones. For example, in a harvest of 8000 ears at Santiago de Chiquitos, Bolivia, only four ears differed from the predominating type, yet in a collection representing this lot, three of the atypical ears were included and only four of the major type.

There is a further reason why collections made in the market place may not be at all representative. Some of the most distinctive and significant types of maize do not come to the market on the ear and have been missed by collectors. Through most of Latin America there are old-fashioned types of corn which seldom or never appear in the markets but which are used for particular purposes, most of them survivals of pre-Columbian practices. Three examples of such specialty corns are popcorns, brewing corns, and sweet corns.

Popcorns are very widespread in Latin America. A glance at the ethnological and agronomic literature will show that they have been obtained by very few collectors. This is largely because, if marketed at all, it is the popped corn which is sold, usually in various sweetmeats, while the ears do not generally appear. Brewing corns are widely distributed; how widely we cannot say for certain until careful collecting has been done. Since in many places brewing, though common, is illegal, it requires tact and experience and persistence to obtain ears of such varieties. Sweet corns (i. e., maize with one or more of the recessive genes for sugary endosperm) are widespread in Latin America. They are seldom used for green corn as in the United States. They were apparently pre-Columbian sugar sources and have survived in the manufacture of certain distinctive beverages and sweetmeats. They are known in Mexico, Guatemala, Peru, Ecuador, Bolivia, and from the Hopi Indians in the United States. In most of these places the ears are not commonly sold in the market, and it is only through careful field studies that we shall be able to map their present extent and trace their probable history.

For the above reasons the maize samples reported on in this paper were taken from fields, from drying floors immediately after harvesting, or from the cribs *(trochas)*[1] where the maize was being stored. In so far as possible they are random samples of 25 ears from each field. When for any reason they do not represent such a sample the fact is so stated in the Appendix. In making selections from a field the two or three outer rows of plants were avoided as being unrepresentative. An ear was taken from a randomly chosen plant in any one row, from the fourth plant in the next row, from the eighth in the next, and so on diagonally across the field until 25 were secured. In making crib or drying-floor selections the calipers were thrown out onto the surface of the ears and the ear nearest their tip was chosen for measurement. However, nubbins and poorly filled ears were of necessity rejected. It may be well to discuss the reasons behind this decision. In the part of Guatemala where these studies were made, as in most of the United States, each normal plant bears one perfect ear, though all the nodes below the one bearing

[1] Guatemalan spelling of "*troche.*"

the ear are also potentially fertile. In a small percentage of cases one or more of these lower nodes bears an imperfect ear, as do so also occasionally the axillary shoots from the base of the plant (the "tillers" or "suckers"). Most of these small, imperfect ears can be recognized at a glance by an experienced person. In the United States they are called "nubbins"; in Guatemala, "mulco" is the commonest name in the Antigua region. To have included measurements of them with measurements of the upper ear would almost be like including a few leg measurements with arm measurements when studying a human population. The imperfectly pollinated ears are rejected because their kernels do not develop normally and measurements, such as width of kernel, would be almost meaningless.

It may also be well to discuss the actual way in which the collections were made and the measurements obtained. During the long dry harvest season in upland Mexico and Guatemala it is a simple matter in almost any town to find a field which is being harvested or a patio or drying floor where maize is spread out to dry. If the town is Spanish-speaking a request at the gate is almost never denied, particularly if one explains that he does not wish to buy the corn but merely wants to study it. Once permission is obtained one sits down by the corn (or actually on it in the corn crib) and measures his sample of 25 ears. This takes from one to two hours depending upon interruptions. (A pocket full of hard candies to pass out to the children of the household is almost as indispensable as a sliding micrometer.) After the 25 ears have been measured a few of them are photographed, and then one courteously takes his leave. This process is so simple that one can scarcely dignify it with the name of a technique and yet it is of real importance in taking efficient samples of Latin American maize and interpreting the results of such sampling. It is time-consuming but the time is well spent. For the first few moments most of the family stands around watching, and then the spectacle of a strange foreigner carefully measuring ears of the corn becomes dull, even for a Latin American family, and the normal life of the household begins to go on its usual way. Life in such homes is centered about the patio and as one sits there busy with the corn, he learns, incidentally and in a painless kind of way, a great deal about the family who owns the corn. When the men have gone back to work the old grandmother of the family will enjoy discussing the ways in which corn is made for food in her family, and frequently she can supply information about brewing corns or popcorns that cannot be obtained from local agronomists or corn merchants.

Maize is a sensitive mirror of the people who grow it. It is so highly heterozygous that good or bad management and careful or careless selection leave their imprints upon the character of the population. There are so many kinds of corn and they are so different and yet cross so readily that the introduction of alien sorts leaves a permanent witness of the mixture. One cannot interpret population samples of maize efficiently without understanding as much as possible about the people who grew that maize. The long, dull hours spent in measuring the samples of maize yield a priceless harvest of understanding.

The actual results from the Guatemalan studies are presented in Table I and also in the Appendix. The characters measured have been described and discussed in full in "Maize in Mexico" (Anderson, 1946). This discussion need not be repeated here, other than to point out that the characters were chosen after preliminary studies in the field and in the experimental plot. The scatter diagrams used in the Appendix attempt to present a picture of the population sample in one simple, easily grasped diagram. As explained in the introduction to the Appendix, the scoring of kernel texture[1] has been made more objective since "Maize in Mexico" was published. It is now scored in 6 grades as follows:

0. No soft starch at apex of kernel
1. Soft starch but no denting
2. Soft starch and a small dent
3. Soft starch and a deep dent but no wrinkling of the pericarp.
4. Soft starch and wrinkling pericarp
5. Soft starch and the apex of the kernel collapsed

In Guatemala, even more than in this country, the kernels at the tip and the butt of the ear are often different from those in the middle portion. The scores for kernel characters attempt to reflect the average condition of the middle third of the ear.

Through the courtesy of the O.F.A.R. it was possible to make an experimental test of the reliability of the methods of sampling and measurement used in these studies. At the experimental plot at Quezaltenango a common yellow variety from Salcajá had been used in a series of fertilizer test plots. Numbers 1 and 2 in the Appendix show the result of sampling the untreated plot and that to which phosphorus and nitrogen had been added. A random sample was taken from each as it was drying after harvesting, and photographs were made of the corn as it lay out in the sun. As shown in the Appendix, there are only very slight differences between the two samples by the methods used in this study. Maize is so variable and is so visibly affected by differences in soil fertility that I have frequently been asked by agronomists as to how much confidence could be placed in my 25 ear samples. Since the standards by which these sampling methods had been developed are essentially those of most taxonomic work it has been difficult to give an intelligible answer to those unacquainted with taxonomic practice. Though they seldom put it in words, taxonomists learn to choose characters which are relatively stable under environmental variation.

My general approach has been to work out methods of sampling and to choose characters for study which would give consistent results for repeated sampling of the same field, or for different samples of the same variety, and yet were efficient in distinguishing between varieties which were manifestly different. The methods have been used with increasing confidence when they demonstrated the regional

[1] See Anderson & Cutler (1942) for a discussion of the reasons for abandoning "flour," "flint," and "dent" as special texture categories in Central America.

TABLE I

FIELD AND CRIB COLLECTIONS OF GUATEMALAN MAIZE*

Region	Locality	Kernel denting	Ear width (mm.)	Shank diameter (mm.)	Number of rows	Kernel width (mm.)	Number of ears measured
Antigua	San Antonio Aguascalientes	0–1–3	40–50–57	9–17–23	10–14–18	8½–10½–12½	25
	Recolección, Antigua	0–2–4	44–49–59	15–22–31	12–16–18	8½– 8½–10½	25
	Medio Monte	1–1–3	43–47–55	12–17–20	12–14–18	8½– 8½–10½	25
	Dueñas	0–1–3	40–49–52	14–19–26	12–14–18	8½–10½–10½	25
	Dueñas, P. Alegría	0–1–3	45–49–57	13–20–26	10–14–16	8½–10½–12½	25
	C. Vieja, Rosario	0–1–3	47–54–64	12–22–34	14–14–18	8½–10½–12½	25
	C. Vieja, Montañes	0–1–3	44–59–63	14–23–36	12–14–16	10½–10½–12½	25
Sacatepeques	Santa Lucía (amarillo)	0–1–3	36–43–51	12–19–25	8–10–16	6½–10½–12½	25
	Santa Lucía (negrito)	0–1–3	38–43–49	11–16–25	10–10–14	8½–10½–12½	25
	Santa Lucía (blanco)	0–1–2	41–46–52	14–21–28	8–12–14	8½–10½–12½	25
	San Juan de l'Obispo (am.)	0–1–3	41–45–55	11–19–27	10–12–14	8½–10½–12½	25
	San Juan de l'Obispo (neg.)	1–2–3	45–53–60	14–21–33	10–12–16	10½–12½–12½	25
	San Lucas (pinto)	1–1–3	39–43–52	13–19–24	10–12–16	8½–10½–14½	25
	San Lucas (amarillo)	0–1–4	32–39–45	11–15–25	8–10–12	8½–10½–12½	25
	Mixco, A. Castillo	1–1–3	33–42–51	10–20–24	10–12–18	8½–10½–14½	25
Plan de Paramos	Chimaltenango	1–2–3	38–44–55	9–15–20	10–12–16	6½–10½–12½	25
	Paramos (above)	1–2–3	42–45–54	10–14–20	10–12–18	8½–10½–12½	25
	Paramos	1–2–3	43–53–62	17–21–27	12–14–20	8½–10½–14½	25
	San Miguel Morazón	1–2–3	38–42–47	11–16–19	8–10–12	10½–10½–12½	13
Quezaltenango	Salcajá (unfert.)	0–2–4	36–42–48	9–14–19	8– 8–12	10½–12½–14½	25
	Salcajá (fert.)	1–1–3	35–39–49	8–12–19	8– 8–12	10½–12½–14½	25
	High above Zuñil	1–1–2	40–47–51	12–18–27	10–12–14	8½–10½–14½	11
	Above Zuñil (yellow)	0–1–2	39–42–47	11–16–21	10–12–14	8½–10½–12½	25
	Above Zuñil (white)	0–2–3	39–49–56	9–17–25	10–14–18	8½–10½–12½	25
	Nueva Cuartel (white)	1–3–4	41–49–59	5–15–21	12–16–22	6½– 8½–10½	25
	Nueva Cuartel (yellow)	0–2–3	37–43–52	5–14–23	8–12–14	8½–10½–12½	25
	Doña Laura (white)	1–3–4	38–44–50	8–13–19	10–12–16	6½– 8½– 8½	25
	Doña Laura (yellow)	1–2–3	28–36–41	7–11–16	8–10–12	8½– 8½–10½	25

* For each character, the lowest value is given, followed in succession by the average for the collection, and by the highest value. At San Antonio Aguascalientes, for example, the lowest number of rows of kernels on any ear in the sample was 10, the highest was 18. The average value (median) for the collection was 14.

differences of Mexican maize, and the gradual transition from one region to another. However, these are essentially taxonomic judgments and they are not convincing to most agronomists. It is gratifying, therefore, to present experimental data on this point. As can be seen from the photographs, the Salcajá maize differs markedly in yield and vigor and in percentages of imperfect ears under the two treatments. Random selections of well-filled ears, however, yielded two similar samples from the two plots. This is a demonstration of the fact that the characters we have chosen for measurement have a strong germinal basis and that under conditions which will produce approximately normal plants they are not greatly affected by soil differences.

The 30 collections presented in Tables I and II and in the Appendix are from three nearby regions, all in the highlands of Guatemala. Seven are from the Antigua basin at elevations of about 5000 feet. Twelve are from plateaus near Antigua but from 500 to 1000 feet above it. Of these 12, 8 are on the San Lucas plateau or just below it, while 4 are from the Chimaltenango region. Nine samples are from Quezaltenango, a little over 50 miles to the northwest of Antigua and 1000 feet higher.

TABLE II

COMPARATIVE VARIABILITY OF MAIZE COLLECTIONS FROM GUATEMALA AND FROM WESTERN MEXICO

Maximum number of ears (per 25 ear sample) with same row number and kernel width.	5	6	7	8	9	10	11	12	13	14	15	16	17
Guatemala (29 samples)	2	4	3	4	2	3	2	4	1	2	0	1	1
Western Mexico (29 samples)	5	7	3	7	2	3	1	1	0	0	0	0	0

Although the numbers of collections are small, two generalizations can be established from the facts summarized in Table I. Both of them find further confirmation in the Appendix: (1) For the characters measured there is a general trend with altitude for most of the characters. From Antigua (5000 feet) to the plateaus above it (5500 feet), to Quezaltenango (6000 feet), the ears become generally smaller, with smaller shanks and fewer row numbers. (2) Differences between varieties are greater in the Quezaltenango region.

One quite unexpected fact is demonstrated over and over again in the Appendix. Much of the common maize in Guatemala is highly uniform. As will be shown below, there is indeed great variation in type in certain parts of Guatemala, as Mangelsdorf and Cameron pointed out. It is all the more surprising, therefore, to report that in many fields and even within certain regions, the plant-to-plant variation of *Zea Mays* is less than in any other region we have studied, including even the highly selected open-pollinated varieties of the United States corn belt! This is particularly striking in the Antigua region, but the same general tendency

Text-fig. 1. Popcorn balls (some of them wrapped in corn husks) being offered for sale by an Indian woman (upper left) in the market at Patzún, December, 1946.

Text-fig. 2. Corn just brought in from the field, drying in the yard of an Indian home in San Antonio Aguascalientes. Note its uniformity to type.

3

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Text-figs. 3 and 4. Corn in the drying yard of a non Spanish-speaking Indian above Zuñil. Superior and uniform ears laid out to the right (close up in the lower picture) are apparently being saved for seed ears. Note that a few ears with red pericarp are being deliberately included with the white ears, a very widespread practice in the New World among primitive peoples.

will be found to run throughout the collections. It is particularly striking when the scatter diagrams of the Appendix to this paper are compared with those in the report on Mexican maize.

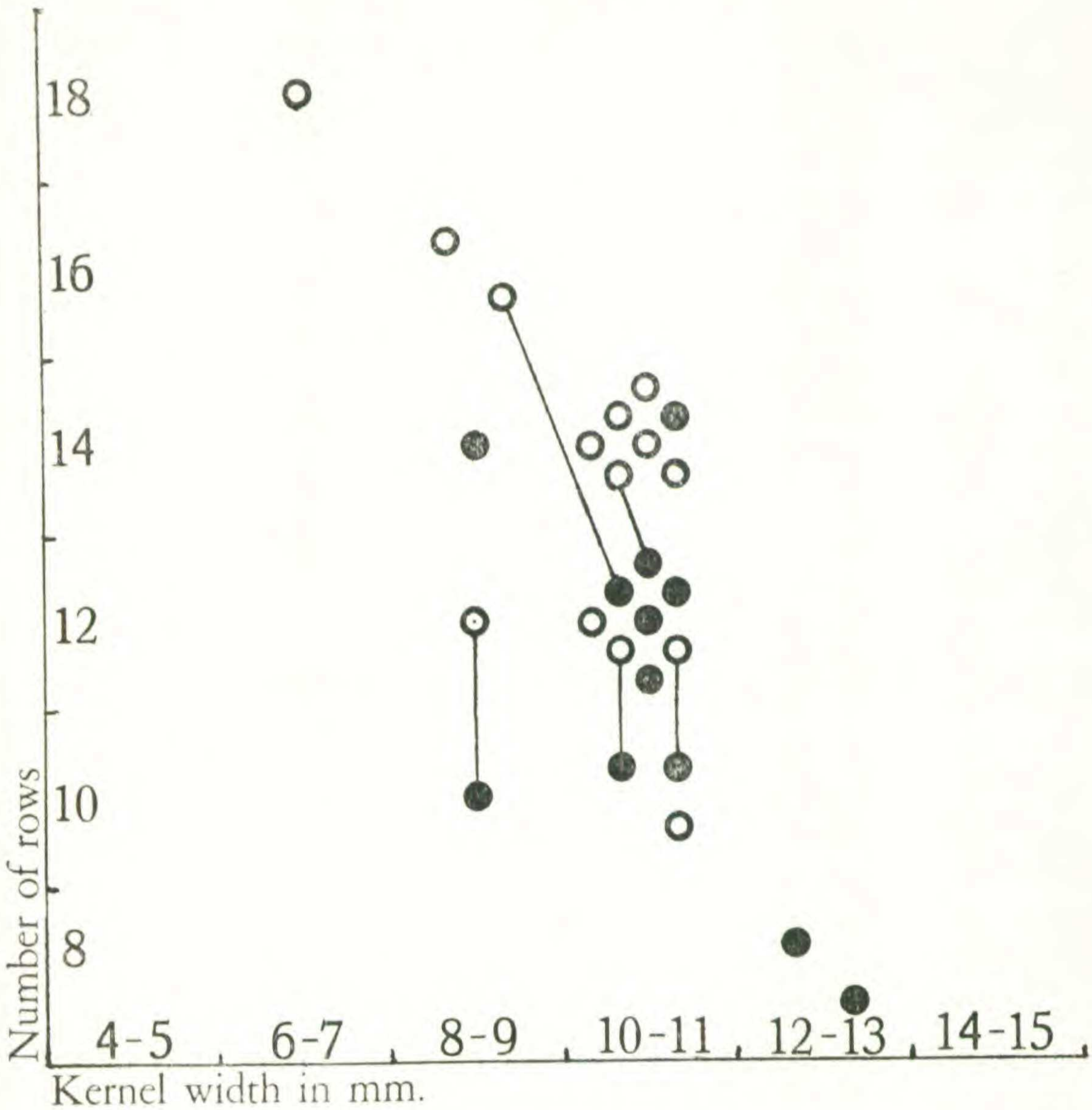
The maximum number of specimens for one of the cells on the scatter diagram is presented in Table II for the 29 Guatemalan collections which had 25 ears each. It is contrasted with a similar summary of the first 29 such collections in the Appendix of "Maize in Mexico." It will be seen that while the Mexican maximum varied from 5 to 12, the Guatemalan maximum went up to 17. The average (median) value of the cell maximum was 7 for western Mexico and 9 for Guatemala. Yet the Mexican collections were made in an area where there are strikingly fewer types of corn per 100 square miles than in the Guatemalan area.

Four of the collections from the Antigua region have from a half to two-thirds of the sample falling in the same cell of the scatter diagram, which means that they have the same row number and do not vary more than one millimeter in kernel width. Somewhat of the same stability is shown when we make comparisons between varieties in the Antigua region. Of the 25 ears each, of the 7 samples, 68 (or just over one-third) fall in the same cell (14-rowed, 10–11 mm. width of kernel) on the scatter diagram.

The reasons for this stability of Guatemalan maize require further study. In part, at least, they rest upon a rigid selection for physical type in picking seed ears. Among pure-blooded Indian farmers maize is often very carefully selected for type. Figure 3 shows the maize drying floor of an Indian family living on the slopes of a volcano above Zuñil. The family was not Spanish-speaking, and those remaining at home fled when we approached. However, as shown in the photograph, some of the best ears had been segregated at one side of the pile. They are obviously seed ears for next year. The rigid selection for type is about on a par with that practiced by farmers of the United States corn belt in the days before "hybrid corn" when most farmers selected their own seed ears.

Of the 11 samples of white corn 6, as shown in fig. 4, had their averages in the same cell of the scatter diagram, with row numbers of 14 and kernels 10–11 mm. wide. It represents a common, well-marked type in the Antigua region where it was seen repeatedly in markets and being packed to market, on drying floors and in the fields. It has (pl. 47, left) an ear of about the same size as United States cornbelt varieties, slightly enlarged at the butt, tapering gently to the tip, usually straight-rowed except for the enlarged basal portion, and very commonly 14-rowed.

As shown in fig. 5, the yellow corns of the same region are fewer-rowed on the average. They too represent a common, widespread type, particularly at higher elevations. On the highlands between Sololá and Totonicapán they represent nearly all the field corns of that area. They are most commonly 8- to 12-rowed, with an even more strongly marked enlargement at the base of the ear than in the white varieties.



Text-fig. 5. Averages of the field and crib samples of yellow and white corn made in Guatemala. Each circle represents the average value for number of rows and for width of kernel of a whole sample of corn from one field. Open circles denote white varieties, solid circles, yellow varieties. It will be noted that the white varieties on the whole have narrower kernels and higher row numbers. In five instances the same farmer was growing both a yellow corn and a white one. A narrow ruled line connects the two varieties in each of these cases. It can be seen that in each of these the white variety had a higher row number than the yellow variety with which it was associated.

In four of the examples in the Appendix (San Lucas, Santa Lucía, Doña Laura, Nueva Cuartel) and in an additional small sample from Jocotenango we have yellow and white varieties grown by the same farmer, or grown in an adjacent field. These five cases are diagrammed in fig. 5. It will be noted that in each instance the yellow variety has a lower row number than the white variety being grown with it. Though some of the yellows have as many rows as some of the whites, the white varieties being grown in those localities had even more.

These facts suggest very strongly that two of the basic elements in the maize of the Guatemalan highlands are a many-rowed white corn and an 8-rowed yellow corn. Though a great deal of mixing has gone on between them, and still continues, the white varieties, on the average, are larger-eared and with more numerous rows, the yellow varieties smaller-eared and fewer-rowed.

Even within the small area sampled by these field studies it is possible to demonstrate Mangelsdorf and Cameron's center of variability in northwest Guatemala. The 8 collections made in the Quezaltenango area are distinctly more variable among themselves than those from in and around Antigua. This is equally true whether one considers single characters (Table I) or the general over-all impression of the ear (Appendix).

Our data are not extensive enough either to prove or disprove Mangelsdorf and Cameron's thesis that this Guatemalan center is connected with the presence of *Tripsacum* and teosinte in the same general area. We have new information on only one point. The commingling of types is not necessarily the resultant of isolation into mountain valleys as they suggest.

Three of our collections were made within sight of each other, on one mountain slope, yet they are very different types of corn. Two of them were from fields belonging to the same family. It may be significant that these 3 collections were made on volcanic slopes above the Samalá River, which has been since pre-Columbian times one of the easiest approaches[1] from the coast into the highlands. Yet it is in this same area that varieties most like those of central Mexico are encountered. They have the sharply tapering ears, and the pointed kernels which characterize the common varieties of the Mesa Central.

It may be, as Mangelsdorf and Cameron suggest, that the conspicuous variability of the maize of northwest Guatemala is due to the actual commingling there of *Tripsacum, Euchlaena,* and *Zea.* On the other hand, from the available facts one could argue quite as well that Guatemala is a center where diverse strains of maize, which were differentiated elsewhere, met and hybridized. Nor are these two hypotheses mutually exclusive; it may be that the extreme variability of the maize of Guatemala is in part due to very different varieties from South America and from Mexico having met and hybridized at that point, and in part due to distinctive qualities acquired there by introgression from *Tripsacum.* These are questions which cannot yet be answered until we have reasonably complete population samples of Guatemalan maize.

If teosinte originated in the highlands of Guatemala as Mangelsdorf and Cameron suggested, and has there introgressed most extensively with maize, we might expect to find the maize of that area strongly tripsacoid in character. From the published accounts of Corn × Teosinte back-crossed with corn we might expect to find a high percentage of varieties more or less long-eared and few-rowed, with tapering, appressed ears. They would be borne on tough, narrow-leaved, slender-

[1]See McBryde (1947), footnote page 10.

stalked plants with strong root systems. Such varieties seem to be absent in the highlands of Guatemala but they do characterize wide areas in western Mexico. In the deep *barrancas* of western Mexico *Tripsacum* grows in variety and in profusion. It is there that the Tarahumare Indians are known (Lumholtz, 1902) to interplant maize and teosinte to introduce drought resistance and flavor to the former. It is there that *maíz chapolote,* a coffee-brown popcorn, one of the most tripsacoid of maize varieties, is and was commonly grown as a staple.

The varieties of the Guatemalan highlands often possess the low row numbers to be expected from teosinte but they combine the character with wide seeds, a large and differentiated butt, and a thick shank. The origin of these two latter characters is difficult to explain on any hypothesis. They reach greater extremes in Guatemala than in any other area known to me and characterize most of the maize of the highlands. This is particularly apparent when Guatemalan collections are compared with those from Mexico. This can be demonstrated when ear base outlines traced from photographs are compared for Guatemala, western Mexico, and central Mexico. The slight increase in diameter demonstrated in such photographs tends to be accompanied by changes in kernel rowing and even in kernel shape, as can be seen in the Appendix to this paper.

It is difficult even to suggest how such enlarged ear bases might have originated. Perhaps they came from crosses between cylindrical-eared varieties and short-eared, globular types like those of the Andes. They are altogether lacking in the extensive collections of prehistoric maize from western South America. They are developed only to a minor extent in present-day Andean varieties. They are not found over wide areas in Mexico, and in the few cases where they are highly developed (Chiapas, Mountain Yellow) it is fairly obvious that they have spread from Guatemala.

Their behavior in crosses indicates a multigenic basis, and it is difficult to see how they could have originated out of pre-existing maize varieties even by strong selection. There is no transparent reason why they might have originated by hybridization with *Tripsacum* or teosinte. It may be that they are in some way a recombination of genes from South American and Central American maize and that they are most strongly developed in Guatemala since it was there that mixtures of these two diverse stocks took place on a wider scale than elsewhere.

However these enlarged bases may have originated, their occurrence outside of Guatemala is an almost certain indication of a greater connection with the maize of that region. They are well developed in eastern North American flints (Brown and Anderson, 1947) and are only one of several characters which those varieties have in common with Guatemalan varieties.

More precise cytological and histological tests are under way. The "Mountain Yellow" varieties reported from Mexico also show obvious Guatemalan relationships. In the American Southwest, where the prehistoric record has been most completely analyzed, enlarged bases appear suddenly in Pueblo III (Carter and Anderson, 1945) and have characterized the region ever since. Carter and Anderson referred to these Pueblo III long-eared corns as "Eastern" because of their close resemblance to Eastern American flints. There is as yet no evidence concerning the immediate center from whence they came. Whether it was from Mexico, or from eastern North America, or from the Great Plains, it is probable that ultimately, by some route, they trace back to Guatemala.

POPPING AND BREWING VARIETIES

These have been almost universally neglected by collectors. Mangelsdorf and Cameron list one popcorn and no sweet corns. McBryde (1947) mentions it only from Patzún. The Russian Expedition lists none of either type. Stadelman (1940) lists one sweet corn, and none of these authorities make any mention of varieties used for brewing. Though I was not able to study field samples of any of these special kinds of maize, I did collect a few ears. It seems probable that such varieties are fairly common in Guatemala. Since this statement will be received with almost equal skepticism in the United States and in Guatemala, it may be well to discuss the probability in detail. The explanation is of greater importance because the situation is not limited to Guatemala but is quite general in many parts of Latin America.

Certain distinctive types of maize continue to remain unknown because they are grown by non Spanish-speaking Indians ("indigenas"). These distinctive varieties are either used exclusively by the "indigenas" or are manufactured into products which do not readily betray their origin when they appear upon the market.

The gulf between the "indigena" and the "ladino"[1] is much greater in Guatemala than one might suspect from casual observation. The "indigenas" make up the bulk of the population. They are common everywhere, even in the capitol city, and many of the "ladinos" show unmistakable evidence of considerable Indian ancestry. It is not until one begins to investigate customs or products which are peculiarly Indian that he finds out how completely these two kinds of people go their separate ways, and how little one knows about the other. A woman from an Indian town may come into market regularly for most of her adult life but beyond the few words used in buying and selling she will have no knowledge of Spanish. A ladino family may live in a largely Indian village for generations and deal in agricultural produce, yet have little knowledge of those Indian food crops which are not brought to market. My understanding of this phenomenon is the result of efforts to obtain Guatemalan varieties of popcorn for study. It may be worth while to describe these in some detail, since they illustrate the difficulties en-

[1]For a complete discussion of the terms "ladino" and "indigena" see McBryde (1947).

countered in getting a complete understanding of maize in Latin America, and explain why certain very important types of food plants are still almost unknown to science.

I went to Guatemala knowing that popcorn had been collected there at least once, and with a general picture of its distribution and importance in Latin America which convinced me that it must occur in Guatemala, at least in the back country. From Erwin (1934) I knew that a popping Amaranth was also being grown in southern Mexico. I had been successful, under the tutelage of Dr. Isabel Kelly, in finding popcorn in various parts of Mexico from which it had previously not been reported, and my command of Spanish was sufficient to discuss the matter with all the Spanish-speaking people I encountered.

During my first three weeks in Guatemala I got almost exclusively negative results, though I now know that I was sometimes within sight of mountain fields where popcorn was being grown. Various visiting American collectors, most of whom had been on the outlook for strange varieties of maize, knew nothing about it. The staff of the National School of Agriculture was similarly uninformed, though they had an excellent and detailed understanding of the field corns of Guatemala. American residents of Guatemala and Guatemalan farmers, merchants, housewives, and landed proprietors gave equally negative replies with the exception of Mrs. Mildred Palmer, a specialist in Guatemalan textiles, who has direct business connections with various Indian villages. She assured me that popcorn balls were very commonly made and sold in various parts of Guatemala, though she knew nothing about the varieties of maize from which they were made. The ethnologists of the Instituto de las Indigenistas knew little about the matter but were most cooperative in gathering further information. They were soon able to supply me with a single ear of popcorn from the Quezaltenango region and the advice to try making collections in the town of Patzún.

In Patzún I got in touch with the local corn merchant, a most intelligent man, who had a wide and accurate knowledge of the field corns of the region and a lively interest in varieties of commercial importance. He supplied the information that popcorn balls were sold on market days in Patzún and that they were made exclusively by the Indians from special kinds of maize. He knew little, however, about these varieties. He thought there were two different kinds but was not certain. He thought one had pointed kernels and the other not, but could give no further information. I then hurried over to the town market and found popcorn balls being sold by a number of Indian women, none of whom could speak more than a few words of Spanish. Through an interpreter I attempted to buy ears of popcorn or at least seeds of that variety. The women attempted to pass off seeds of ordinary field corn as the source of their popcorn balls. As can be seen from the photographs in fig. 1, the kernels in the popcorn balls are fully exploded and could not have come from any such variety of corn. In the short time before my bus departed, the best I could do was to purchase a small amount of a rather mongrelized popcorn and to arrange to have more authentic specimens purchased and mailed to me. They proved to be a most interesting variety with phenomenally large kernels for a popcorn, but they pop uniformly well. The kernels are wide and quite thick, with no indications of a point, and have a translucent white endosperm. The ears are slender, with 10–12 rows of kernels. They are quite unlike any native or commercial varieties of popcorn known to me.

The popcorn balls from this market led to further information. They were immediately recognized by every one in the servant class (i. e., people of predominantly Indian ancestry) to whom I showed them in the town of Antigua. They are known as *alborotos* and are very commonly[1] brought into town during Lent by Indians from Patcicía, a town near Patzún. (See also McBryde, page 10). The landed proprietors of Antigua to whom I showed them had either never noticed them before or did not know that they were made of maize. One well-to-do "finquero" who makes journeys to Chicago and San Francisco every few years told me that these popcorn balls were made from a plant closely related to "nihau" *(Amaranthus)*! I have not yet been able to collect any considerable amount of popcorn from Guatemala but on two occasions (above Zuñil and above Sololá) I have seen fields of an extremely small-caned maize growing in good land next to fields of large maize. It must have been either a popcorn or a special variety used in brewing.

The difficulties encountered in collecting popcorn are magnified in getting examples of varieties used in brewing or information about their use. More than one kind of home-made alcoholic beverage is made from maize in Guatemala, but such manufacture is illegal and one has to have the confidence of his informant if much is to be learned. In the short time at my disposal I was able to determine that varieties with a blue aleurone were preferred for this purpose, since they were sweeter and smoother. I was also assured by a most intelligent "ladino" woman, who lived in a town largely composed of Indians, that they had certain highly prized varieties used in brewing their ancient types of beverages. It it highly probable that ancient varieties with sugary endosperm are still in existence in Guatemala and that they are probably used in brewing there, as in South America. Stadelman lists a single ear, and his description reminds one of the *maíz dulce* discovered by Kelly in western Mexico (1943).

For the above reasons it is evident that we still know little or nothing about some of the most interesting varieties of maize in Guatemala, and that it will require patience and very special skills to obtain a full understanding of these types. The effort is worth while, not only because such information will illuminate the history of maize, but because, singularly enough, it is among such specialty corns that useful genes for modern corn-breeding are quite likely to be found (see below).

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[1]Though similar confections made from a popping Amaranth and a popping sorghum are even more common.

Salpor.—

Unfortunately none of the fields included in this survey was planted to the highly developed "Salpor" or Flour Corn. This is a large-kernelled variety of white flour corn which is commonly grown in parts of the Guatemalan highlands. Judging from samples displayed in several markets, a good deal of the maize sold under that name in Guatemala is extensively contaminated with other kinds of corn. It very closely resembles the "*Cacahuazintle*" flour corns of Mexico which were probably derived from it, and is quite similar to the highly developed flour corns of Andean South America from which it may in turn have been derived.

Multiplication.—

Cutler has recently described under this name a bifurcation of the spikelet pedicel which increases the kernel number in South American maize. In its lowest grades it is responsible for the extra kernels pushed in between the regular rows of 8- and 10-rowed varieties. With a higher degree of expression it turns 8-rowed varieties into 4 quadrants, within each of which the rowing is irregular and obscure. In its extreme manifestation it produces an ear in which the regularity of the rowing, as in the "Country Gentleman" sweet corn, is no longer apparent. Though these ears look superficially similar to "Country Gentleman," they owe their increase in kernel number not to the development of the aborted floret (as in "Country Gentleman"), but to a doubling of the entire spikelet.

Multiplication is a common phenomenon in Guatemala and from cursory observation is more frequent and more extreme at higher altitudes. Actual percentage frequencies were obtained for several of the collections and are presented in the Appendix (nos. 6, 9, etc.).

Practical Considerations.—

A number of different agencies in Guatemala are already concerned about the yields of Guatemalan varieties, and breeding programs are already under way to improve them. American agronomists, or Guatemalan agronomists trained in the United States, are prone to begin any improvement program along the lines which have proved so conspicuously successful in the United States. In my opinion, this is ill-advised. In the first place, the variation pattern of *Zea Mays* is wholly different in Guatemala from what it is in the United States. In the second place, the conditions under which it is now grown and under which it is likely to be grown in the near future are different there and here. Hybrid corn owes its superiority in the American agricultural picture as much to its uniformity as to its superior yield. Except on a few large plantations there is little prospect of growing Guatemalan corn with power machinery by mass-production methods. Under Guatemalan conditions, therefore, the uniformity of hybrid corn would be of no particular advantage. The other advantage of hybrid corn, extreme heterozygosity, might well be achieved in Guatemala by much simpler methods. The fields in the Quezaltenango area suggest that Mexican varieties with many-rowed, more or less pointed kernels combine well with Guatemalan varieties. It would be a comparatively simple matter to select open-pollinated varieties of white Guatemalan maize and of white Mexican maize which combine well with each other. They could be grown and improved by mass-selection methods. If the maximum improvement was worth the time and expense they could then be carefully selected every five or six generations for their combining ability with one another, using a modification of the plan originally selected by Hull (1945) of Florida. These two elite white varieties, each increased as an open-pollinated crop, could then be interplanted and detasseled as is hybrid corn in the United States, producing first-generation hybrid seed for sale and distribution.

The probable usefulness of Guatemalan maize in the United States.—

Since maize is of even greater importance in the United States than in Guatemala, the extreme over-all variability of Guatemalan maize is of great potential importance to our agriculture. This does not mean, however, that Guatemalan maize varieties, as such, can immediately be used in the production of better corn for the United States. As agronomy advances and it becomes increasingly practical to breed for particular characters in maize, Guatemalan varieties should prove increasingly useful. Resistance to particular diseases, high percentages of unusual amino acids, kernel texture, insect resistance, sugar content, etc. are characters which might well be expected in one Guatemalan variety or another. Once located, it would be a comparatively simple matter to transfer any particular one to a commercial inbred line. Once they are so incorporated they may be used effectively in the production of commercial hybrids for the United States.

It should be pointed out that in any such discriminating corn-breeding program as that just outlined all Guatemalan maize is of potential importance. As a source of disease-resistant genes or of increased quantities of useful amino acids, some small-eared, small-kernelled variety from the mountains may be quite as useful to United States agriculture as the large-eared sorts of spectacular productivity. It is even possible that some of the out-of-the-way varieties may be more useful than the ordinary run of Guatemalan field corns. To be specific, the popcorns and brewing corns are extreme types morphologically; the chances are good that they may also be extreme in their chemical composition and their disease and insect resistance. For purely practical reasons, therefore, Guatemalan corns should be systematically and comprehensively surveyed without reference to their immediate usefulness as field corns. We need, in the first place, a general survey of what kinds of maize there are in the country, what their general morphological characters are (row number, kernel texture, etc.). Then we shall be ready to make a systematic survey of their chemical compositions, disease resistance, etc., and will know where to turn for the characters we need in United States corn breeding.

Summary.—

1. Field sampling of maize is contrasted with sampling at markets and fairs. The latter is shown to give an erroneous and incomplete picture of Latin American maize.

2. The advantages of personal contact with the families which grew the maize sample are described and discussed.

3. Experimental data are presented showing the relative stability under varying fertility of the characters used in this study.

4. The data from 30 samples from the highlands of Guatemala are summarized in tables, charts, and photographs.

5. Even within the small area covered by this survey it is possible to demonstrate that with increasing altitude there is a general tendency for smaller ears, smaller shanks, and fewer row numbers.

6. In spite of the great over-all variability of Guatemalan maize, intra-field variability (and to a lesser extent, intra-variety variability) is *less* than in any other area from which field samples have been taken (including open-pollinated varieties from the United States corn belt). In part, at least, this uniformity results from a rigid selection for type.

7. The common white maize of this part of the highlands is described and illustrated. It is of about the size of United States corn-belt maize, with ears slightly enlarged at the butt, tapering gently to the tip, and is very commonly 14-rowed. The yellow varieties of the same region are mostly fewer-rowed with an even more strongly developed basal enlargement.

8. Inter-variety variability was slightly larger in the Quezaltenango area and was extreme even between fields on a single mountain side.

9. In the light of these results, Mangelsdorf and Cameron's hypothesis of Guatemala as a center for teosinte introgression is briefly discussed. It is suggested that such introgression might have taken place in western Mexico rather than in Guatemala.

10. The difficulties of securing samples of popcorns and brewing corns are described in detail. It is shown that such kinds of maize may be common and still be outside the orbit of visiting scientists. One variety of popcorn is described and its distribution discussed.

11. The phenomenon recently named "multiplication" by Cutler is common in Guatemalan maize. Frequencies are reported for certain of the field samples.

12. The practical improvement of Guatemalan maize varieties is discussed, as well as the best ways to use Guatemalan maize in the breeding of varieties for the United States. It is suggested that for the United States corn belt, little-known and curious out-of-the-way varieties such as popcorns and brewing corns may be quite as important as Guatemalan field corns of spectacular productivity.

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Explanation of Plates 47 and 48

PLATE 47

Common varieties of corn in the Guatemalan highlands. A little less than natural size (note centimeter scale at the base).

Left: Typical ear of white corn from the region around Antigua. Note the slightly enlarged and differentiated base, the gently tapering ear, the flinty kernel with a conspicuous cap of soft starch.

Right: Typical ear of yellow corn from the highlands. This one was grown at Quezaltenango from seed obtained at Salcajá. The wide flinty kernels were deep yellow; some of them had a slight capping of soft starch. The enlarged base and the slightly irregular kernels are typical. One of the ears from Nos. 1 and 2 of the Appendix.

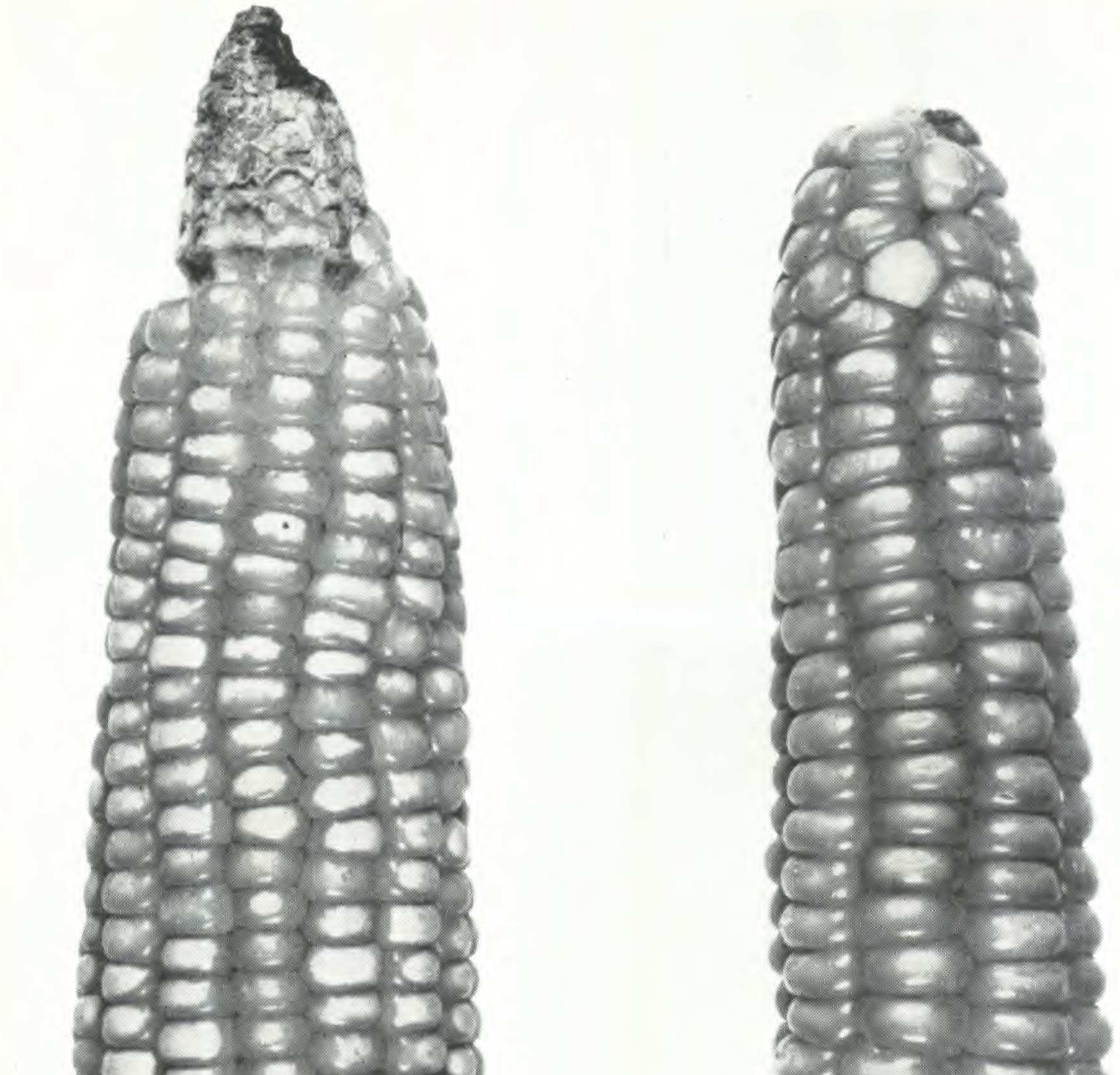
PLATE 48

Ears to the same scale as pl. 47

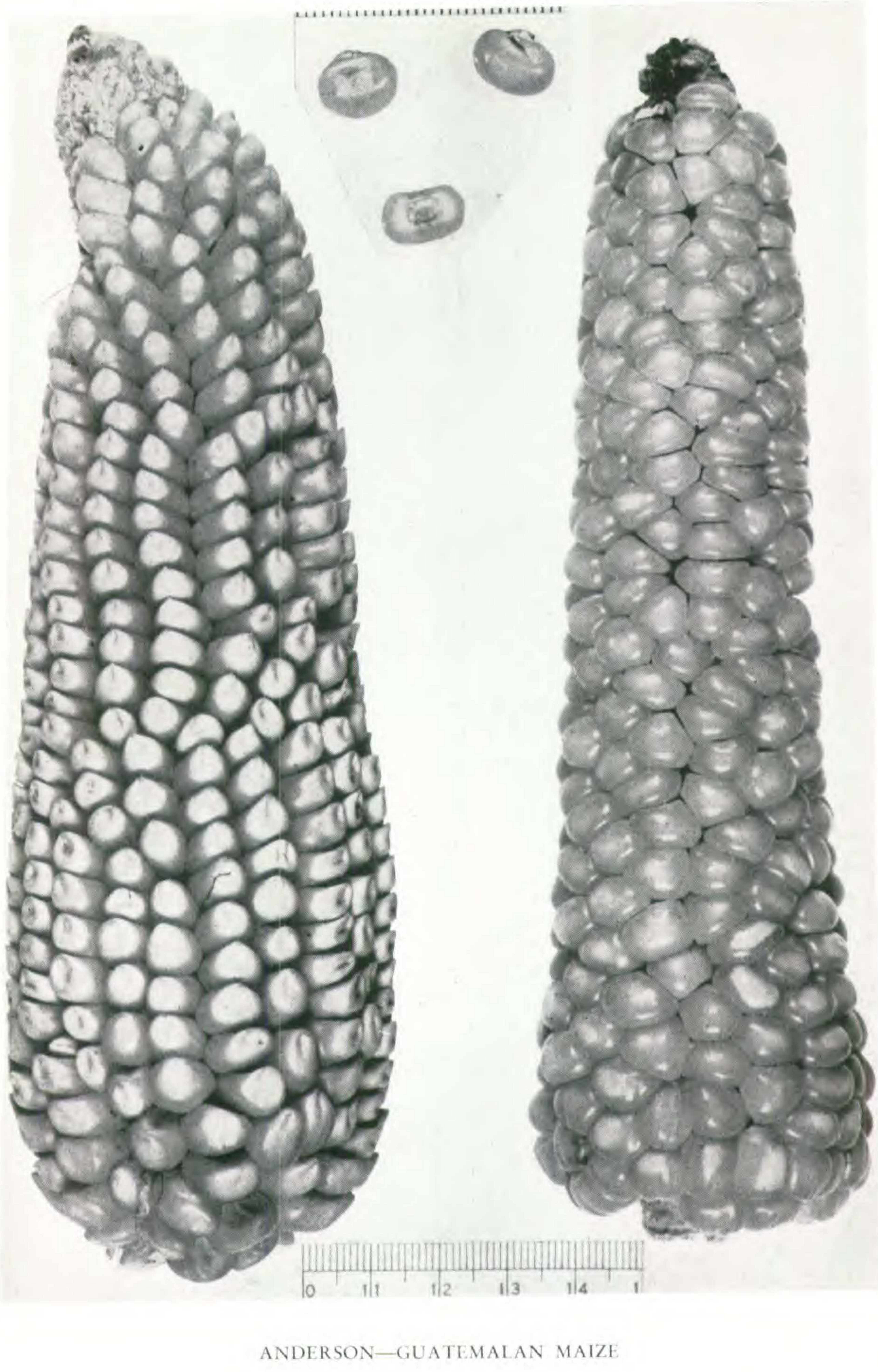
Left: Ear of white corn from Quezaltenango. In its high row number and pointed kernels this variety resembles the common corn of central Mexico. See No. 25 in the Appendix.

Insert: Kernels of popcorn from Patzún, slightly larger than natural size (note millimeter scale along the top edge of the plate).

Right: Ear of yellow corn from above Zuñil (see No. 23 in the Appendix). This is basically an 8-rowed variety with varying amounts of "multiplication." The ear illustrated here has so many extra kernels (due to "multiplication" in the sense used by Cutler, 1946) that the basic 8-rowed condition is almost impossible to follow.



ANDERSON—GUATEMALAN MAIZE



ANDERSON—GUATEMALAN MAIZE

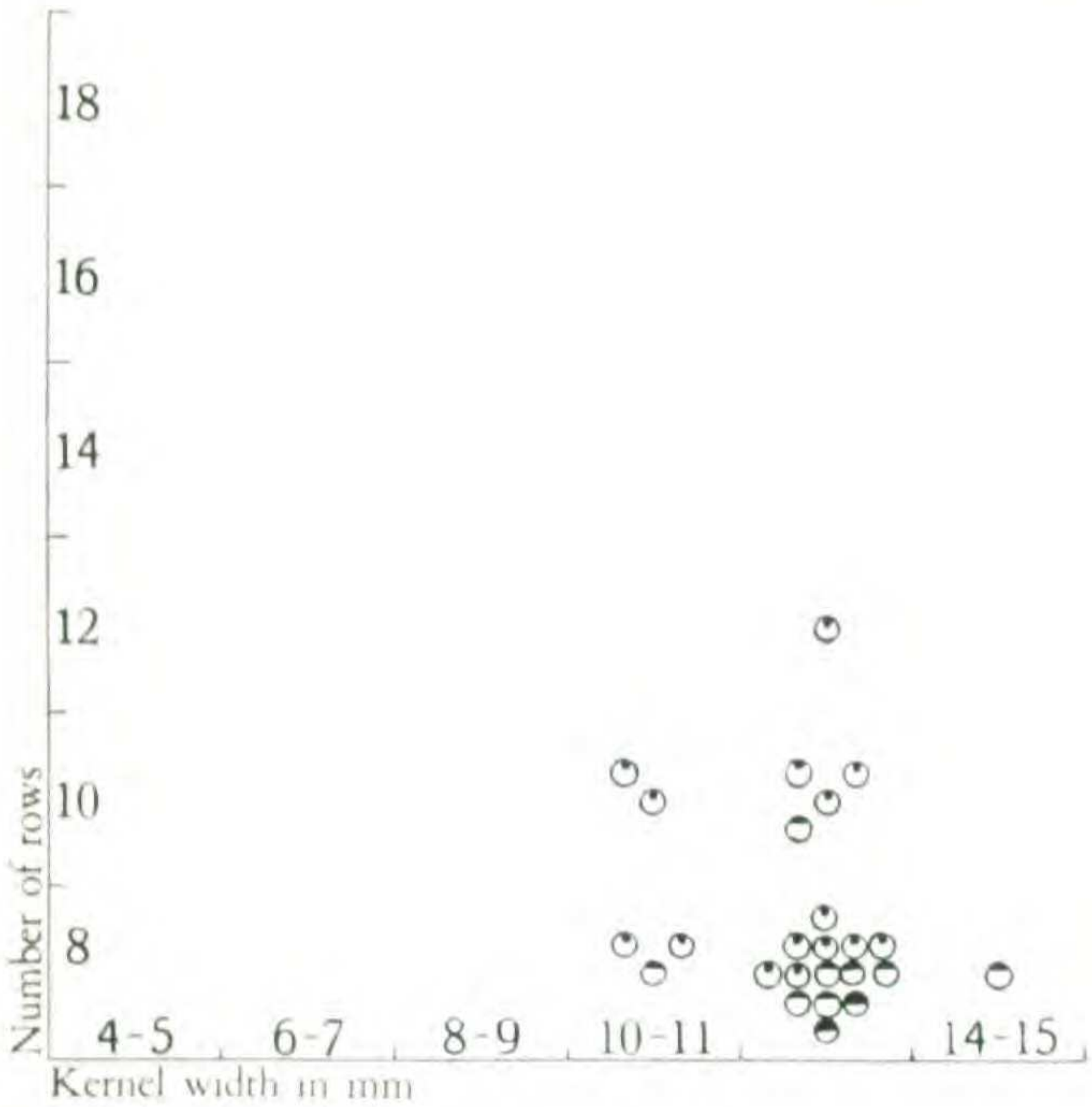
APPENDIX

The Appendix, in so far as space permits, gives a full presentation of the facts summarized in Table 1, along with other relevant data on variation. For many of the collections a Leica snapshot of a random sample of a few ears shows their general over-all appearance. These pictures are printed at approximately the same magnification. The sliding micrometer used in measuring the ears appears in each picture and can be used to make exact comparisons since it is set at 5 cm.

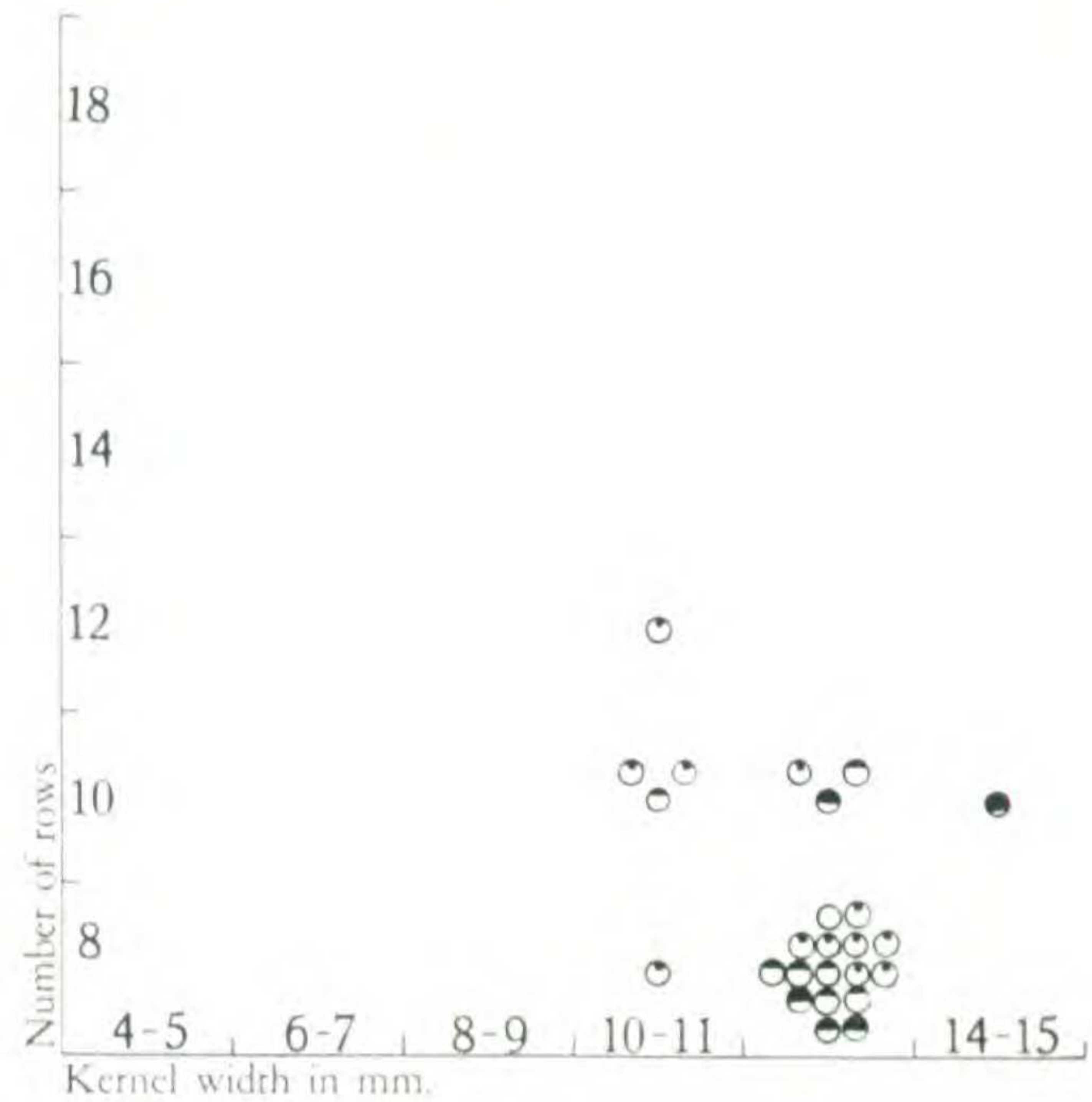
The population diagrams are of practically the same type as those used in "Maize in Mexico" (Anderson, 1946). While they look like correlation tables they are a much simpler device and are more like a scatter diagram; they are merely a way of showing graphically the kernel width, row number, denting of the kernel and pointing of the kernel of each of the ears in the standard 25-ear sample. Since each of these characters is a multiple factor character, and since each is at least partially independent of the other three genetically, the combination of all four provides a record of a good portion of the germ-plasm. The diagrams can be used as a record of what was growing at a particular place and time, as a means of making exact comparisons between varieties or between different fields of the same variety, or (analytically) to examine the effect of a certain variety on the morphology of others being grown in the same neighborhood.

Each little glyph (circular or pointed as the case may be) represents one ear of corn. Its shape denotes the shape of the average kernel on that ear (pointed, slightly pointed, without an obvious point); its color represents the texture of an average kernel. Texture was scored as follows: open circle, no soft starch at the tip of the kernel; open circle with a dot, cap of soft starch but no indentation of the kernel; upper quarter of the circle filled in, cap of soft starch leading to a small indentation of the kernel; upper half of circle blackened, so much soft starch that there is a deep indentation in the kernel but no fine wrinkles on its surface; upper three quarters of the circle blackened, a denting of the kernel plus fine wrinkles in the seed coat; entire black circle, soft starch deposition so extreme that there is a deep wrinkled dent in the tip of the kernel and it is more or less collapsed (this condition, though common in central Mexico, was rare in the part of Guatemala covered by these studies). In other words, the blacker the glyph, the greater is the amount of soft starch.

The diagram can be thought of as a set of pigeon-holes simultaneously cataloguing the ears with regard to their row number (upright scale) and their kernel width (horizontal scale). It sorts out the ears into a series of squares, and all the dots falling in each square represent ears having the same row number and kernel width. The glyphs are arranged in a standardized fashion around the center of each square; variations in position within each of these squares are of no significance. In one or two instances a bar at the side of the glyph is used to mark certain special ears (such as those reserved for seed, or nubbins, "mulcos", etc.).



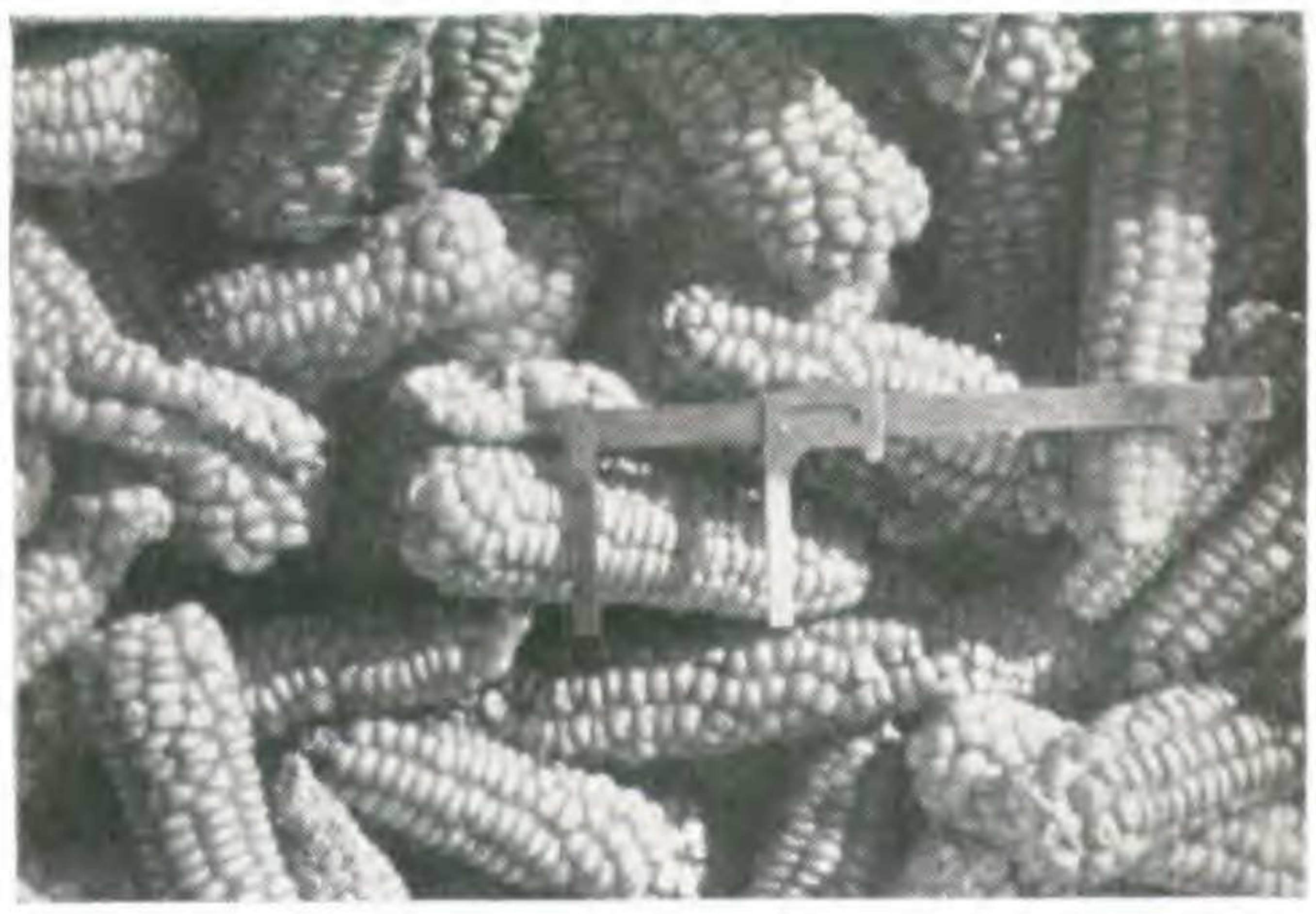
1. Salcajá



2. Salcajá

1 and 2. Common yellow corn from Salcajá. Photographs taken of the harvest at the O.F.A.R. plot at Quezaltenango. No. 1, from a plot fertilized with additional nitrogen and phosphorus; No. 2, the same variety from an adjacent unmanured plot. Though No. 1 yielded much heavier (note that grass is not visible between the ears as in No. 2) and had somewhat longer ears, their kernel type and row number were not affected. In both lots all the cobs were white, all the kernels had yellow endosperm, and there were no kernels with colored aleurone. In each sample of 25 ears, 12 showed multiplication.

1



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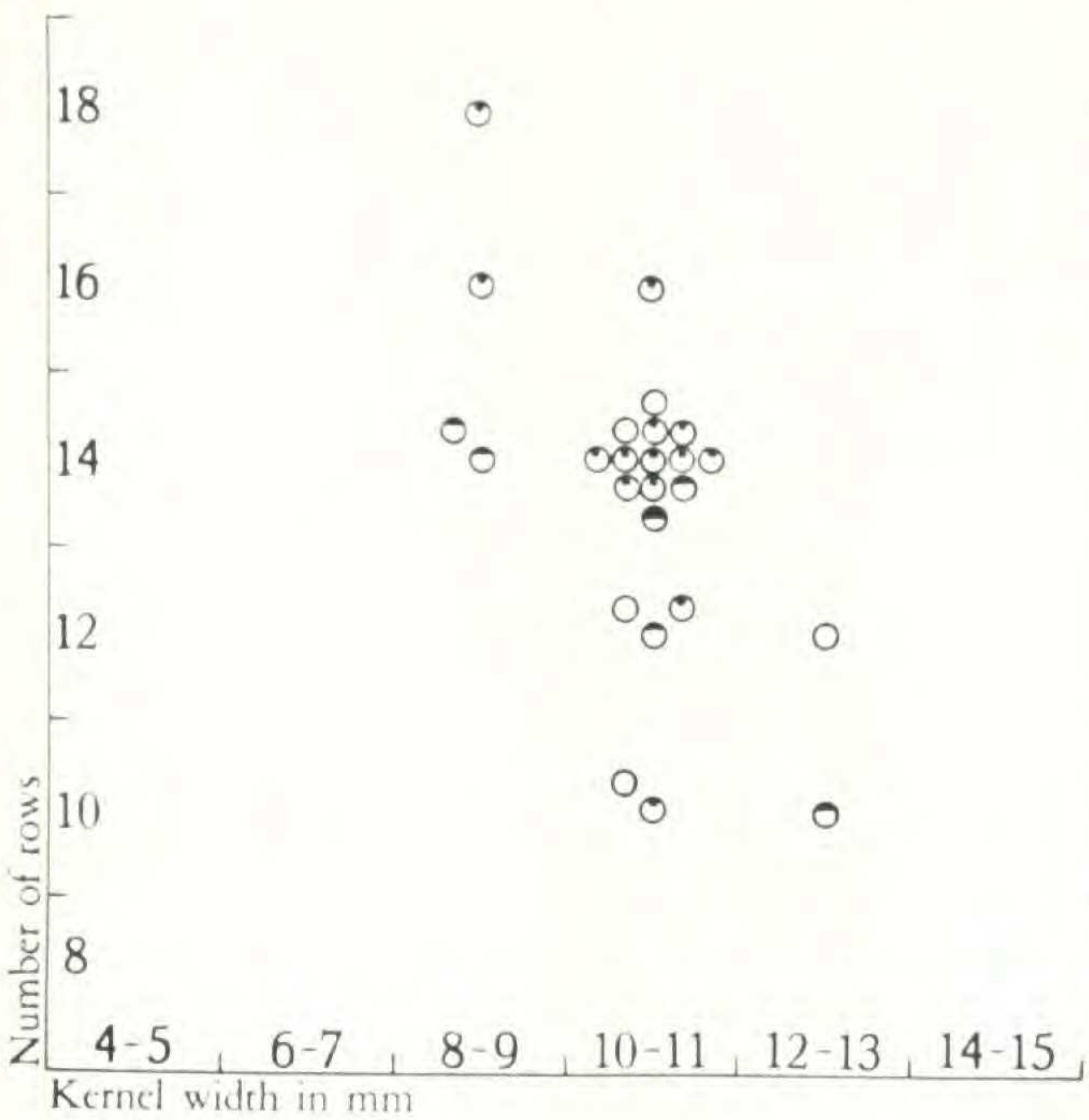
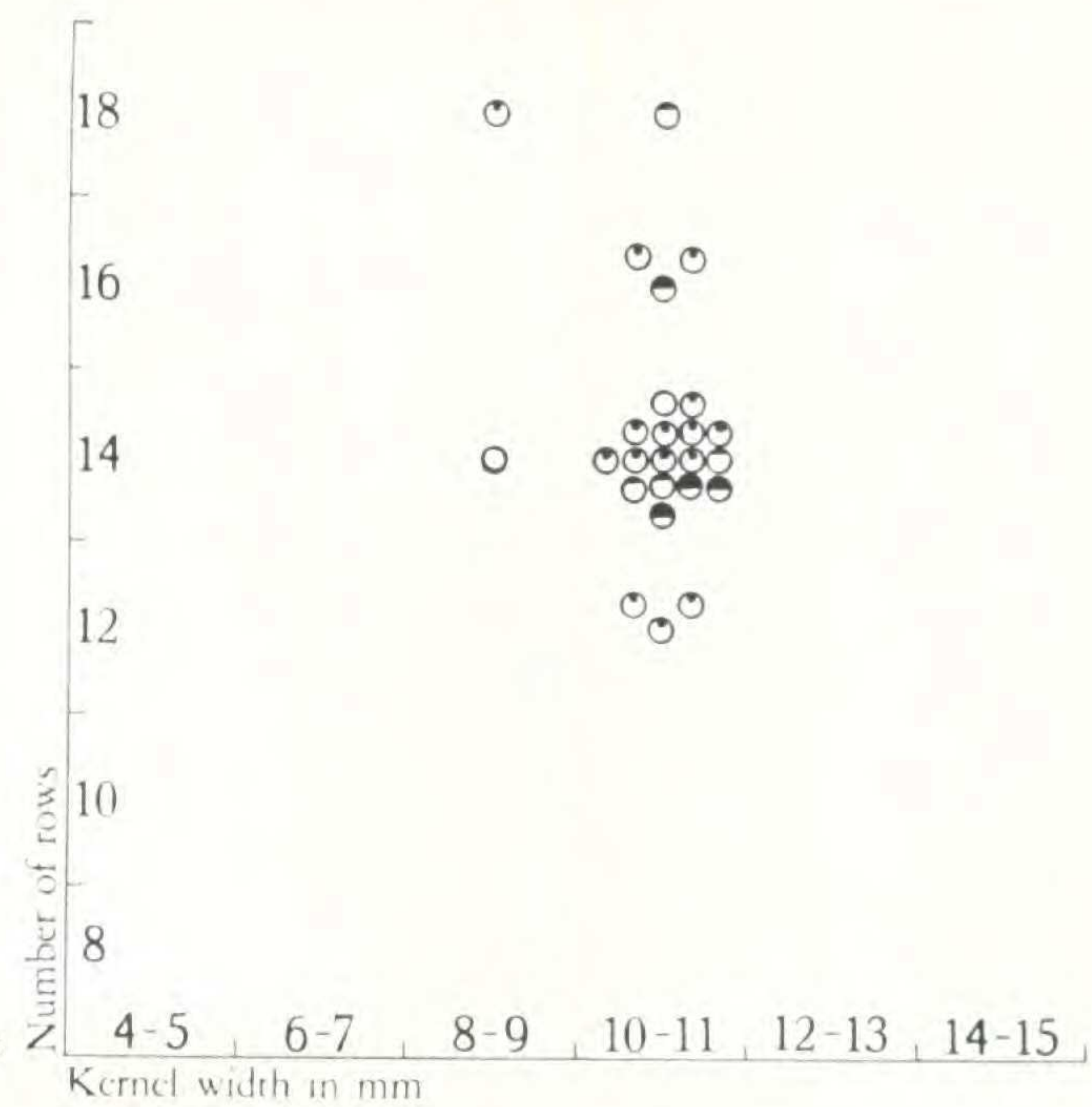


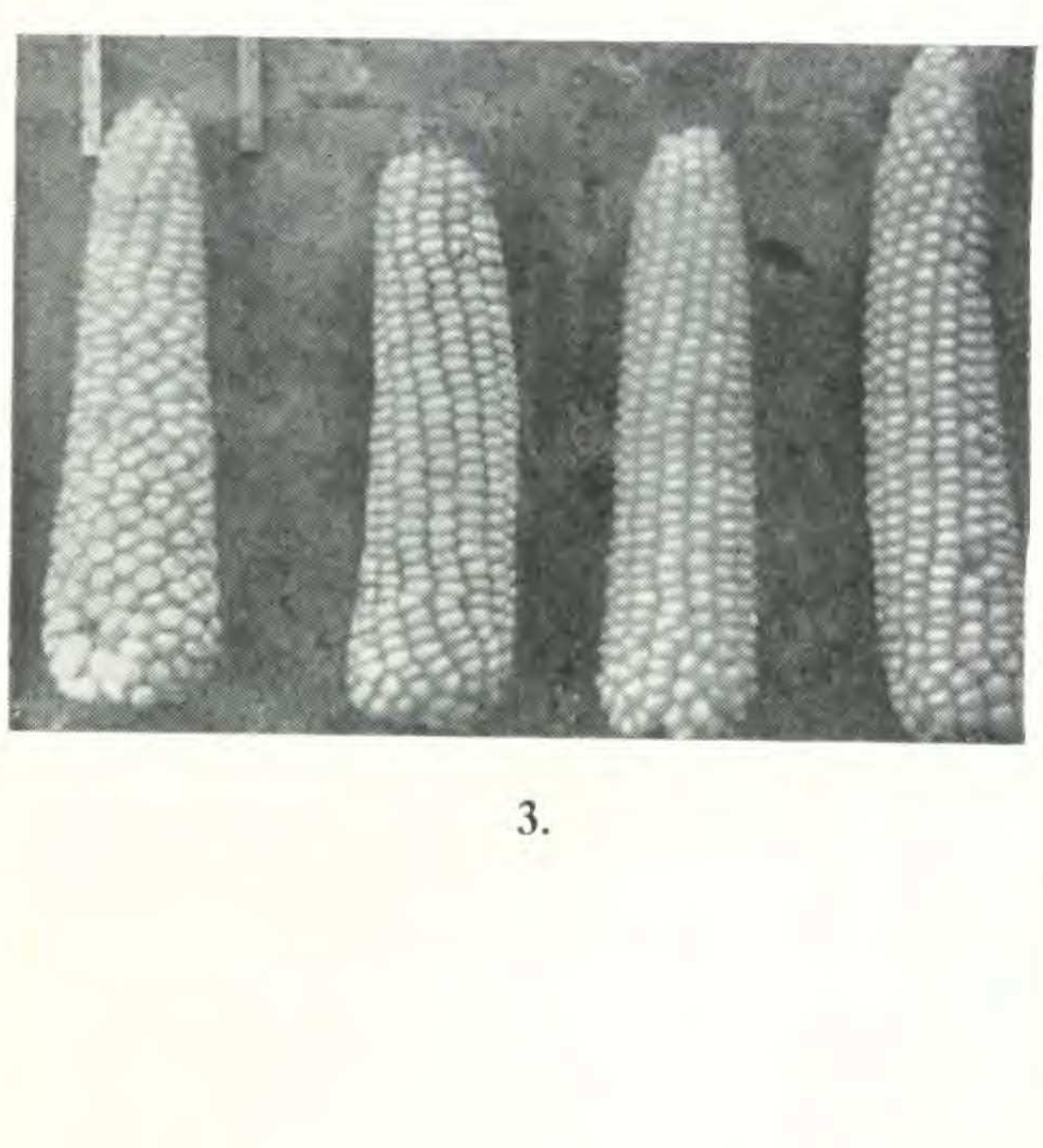
3. San Antonio Aguascalientes



4. Dueñas

3. Common white corn from the purely Indian village of San Antonio Aguascalientes. The corn from this same crib is shown in text-fig. 2. All white cobs. Fourteen ears showed a few yellow kernels, 7 a few with colored endosperm (Pr). Colorless pericarp throughout.

4. White corn from Dueñas. Most of the cobs were light purple, one was deep red, the rest were white. Each of the ears had from few to many kernels with yellow endosperm, 5 ears had a few kernels with colored aleurone (Pr), and 4 had a light flush of color in the pericarp.



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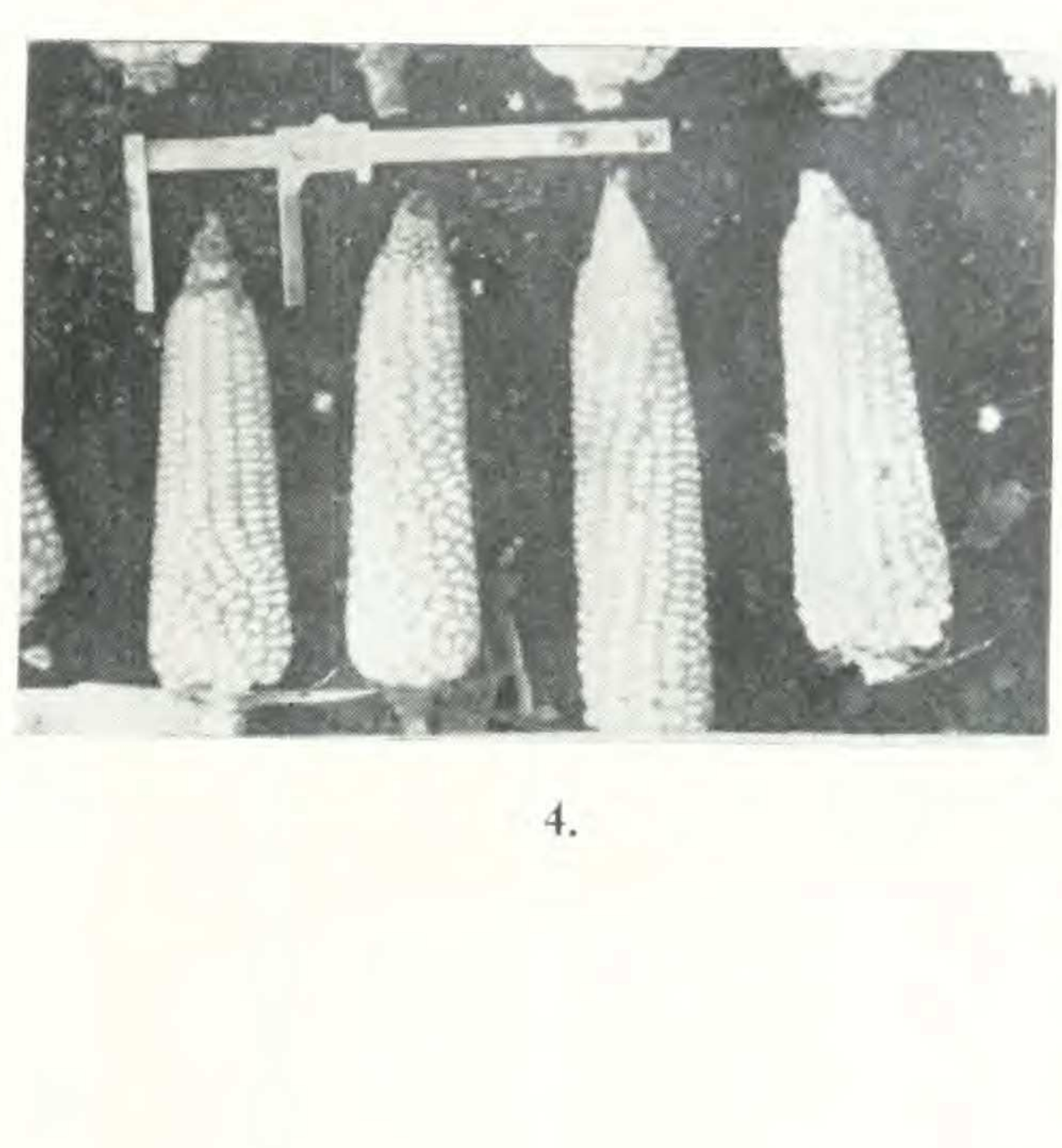

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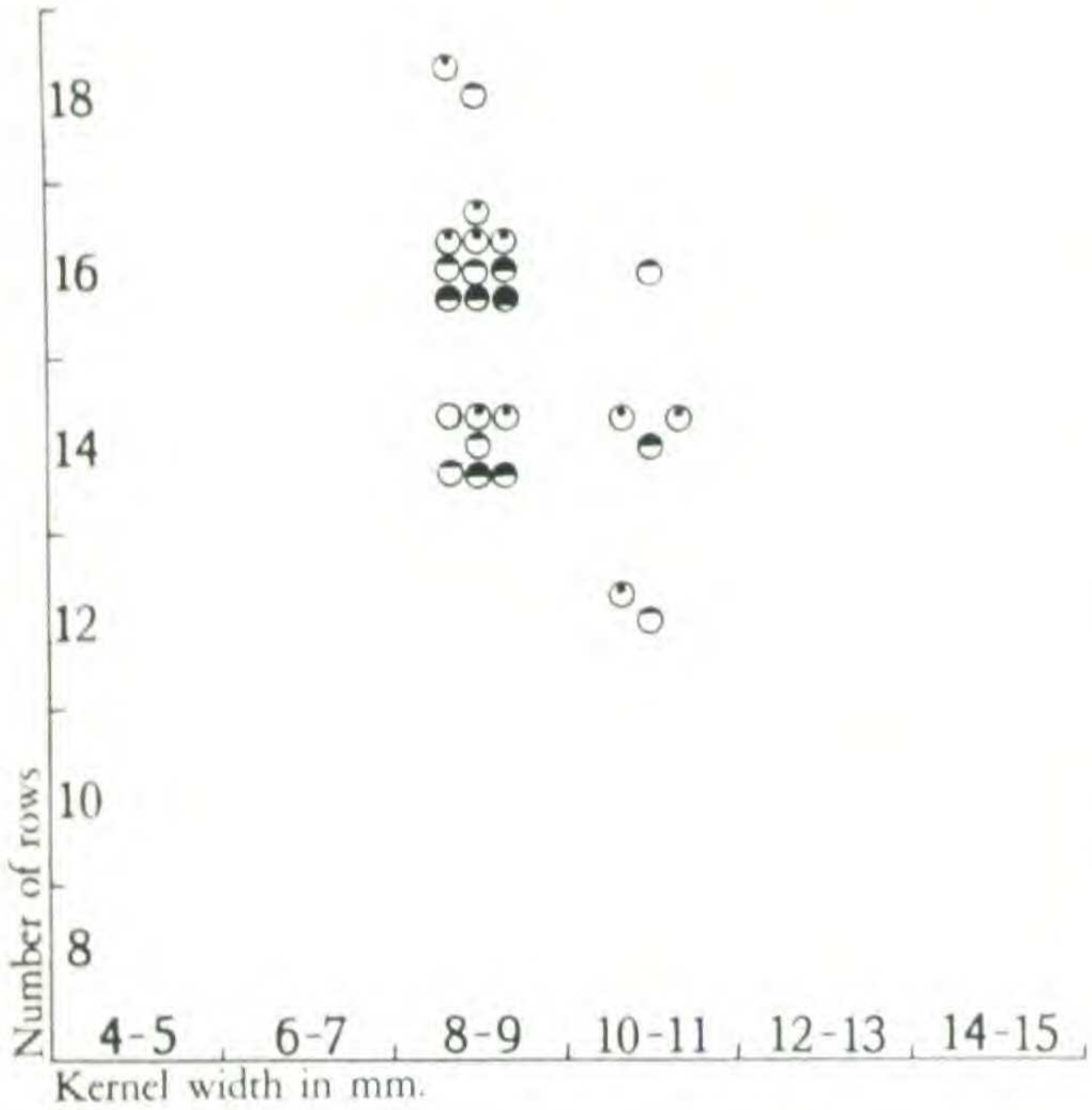
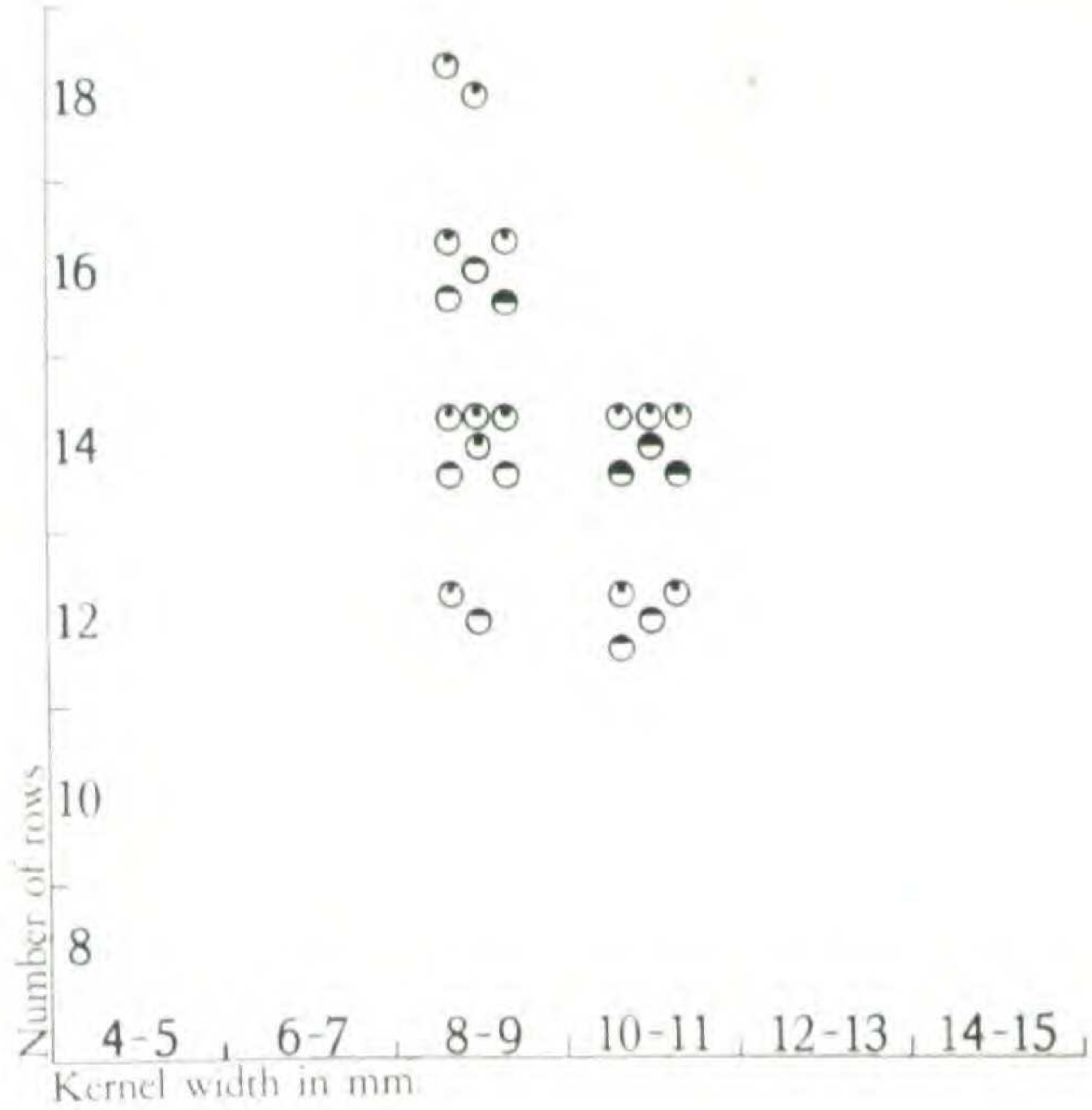


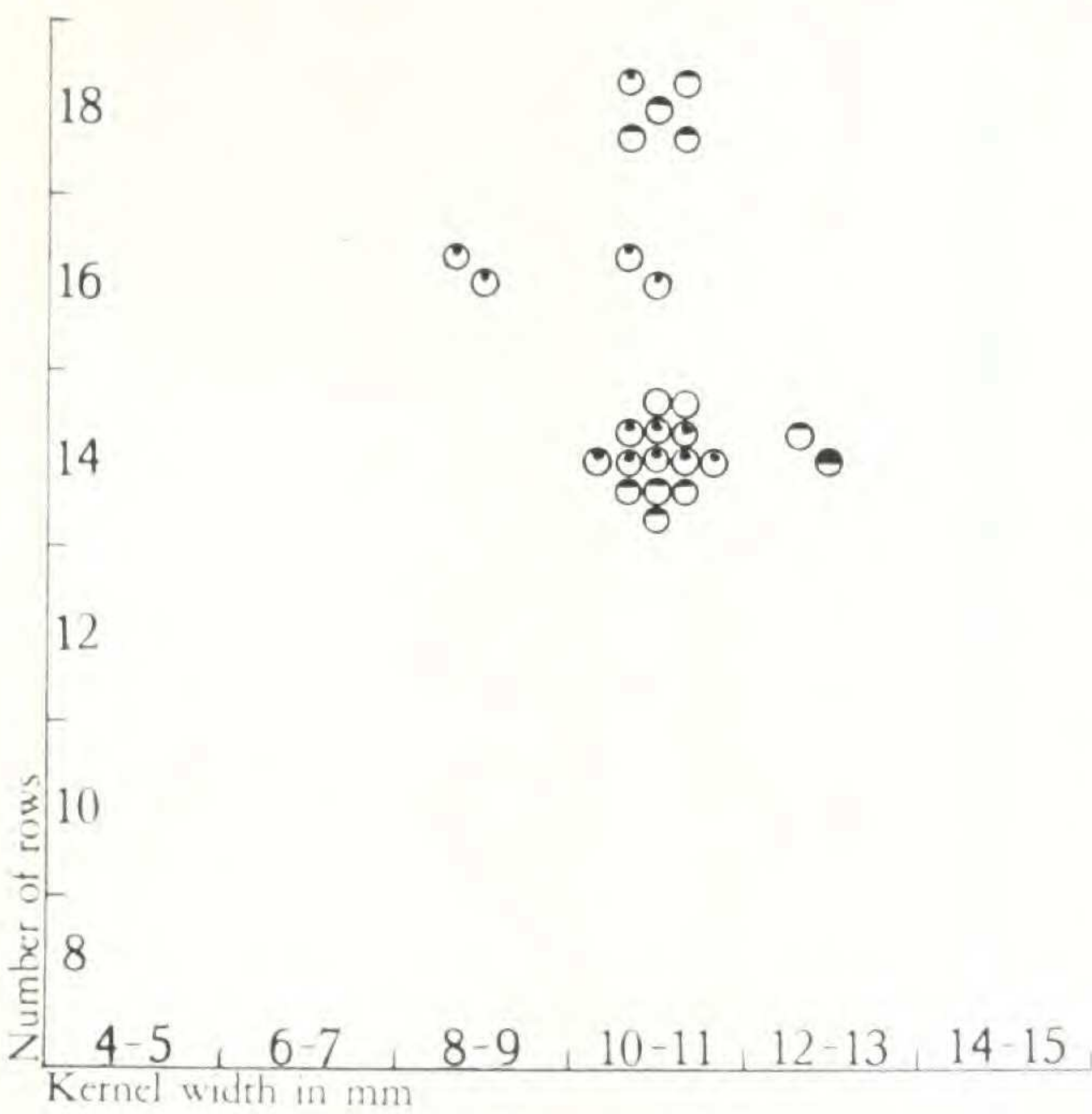
5. Recolección



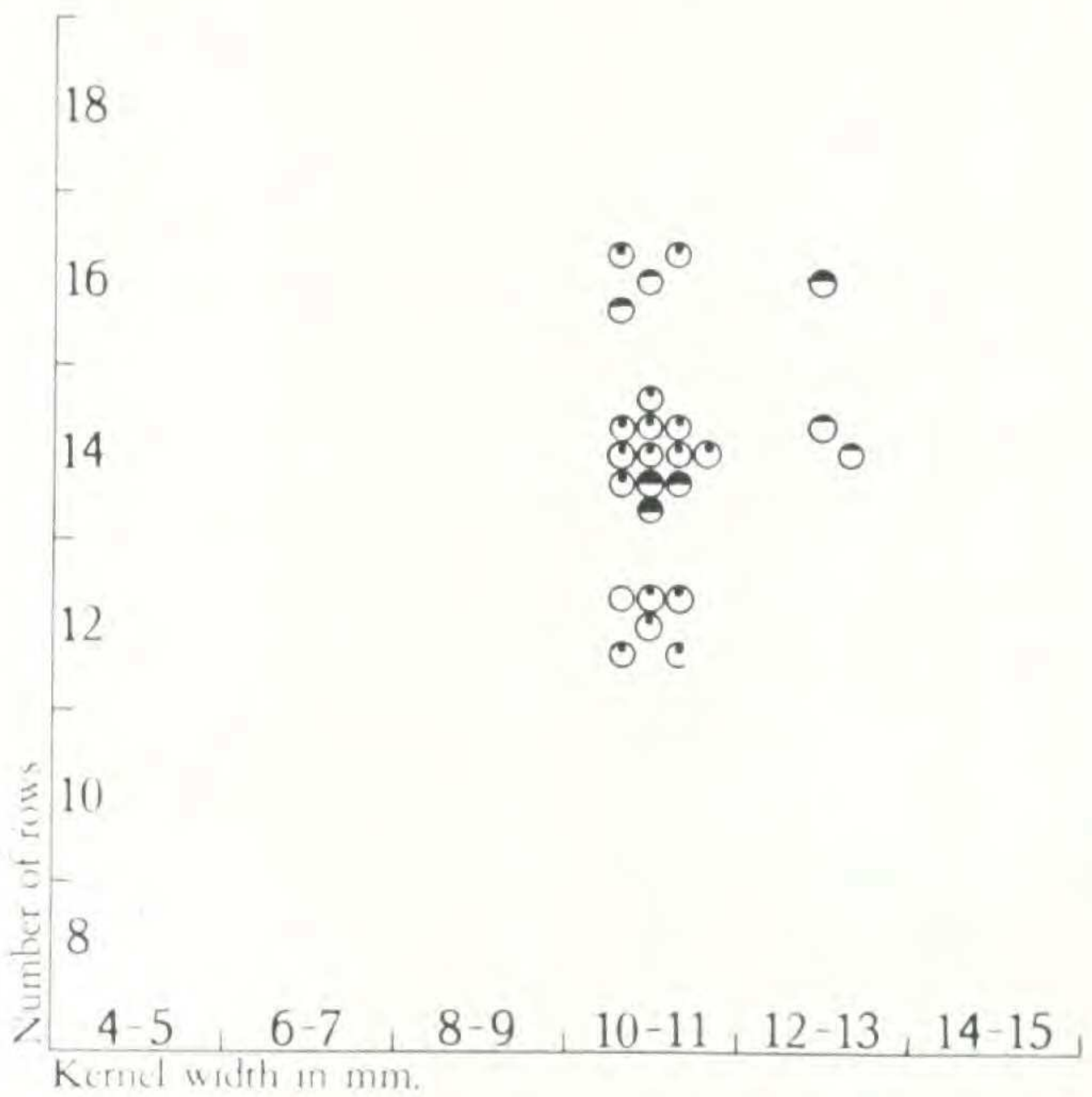
6. Medio Monte

5. White corn grown by a poor family living in the ruins of Recolección, in Antigua. Only 5 ears were pure white, 7 were predominantly yellow, and the remainder had numerous yellow kernels. Most of the cobs were white, 2 were red and 2 a very faint red. Seven ears had occasional kernels with colored aleurone (mostly Pr, but a few pr).

6. This sample of yellow corn was measured in a small crib in Dueñas though the family who owned it had grown it at Medio Monte. Most of the cobs were white, 1 was deep red, 1 purple, and 5 a very faint purple. Six of the ears were segregating for white kernels, and 2 had a few kernels with colored aleurone (Pr). Five of the ears had a light flush of color in the pericarp.



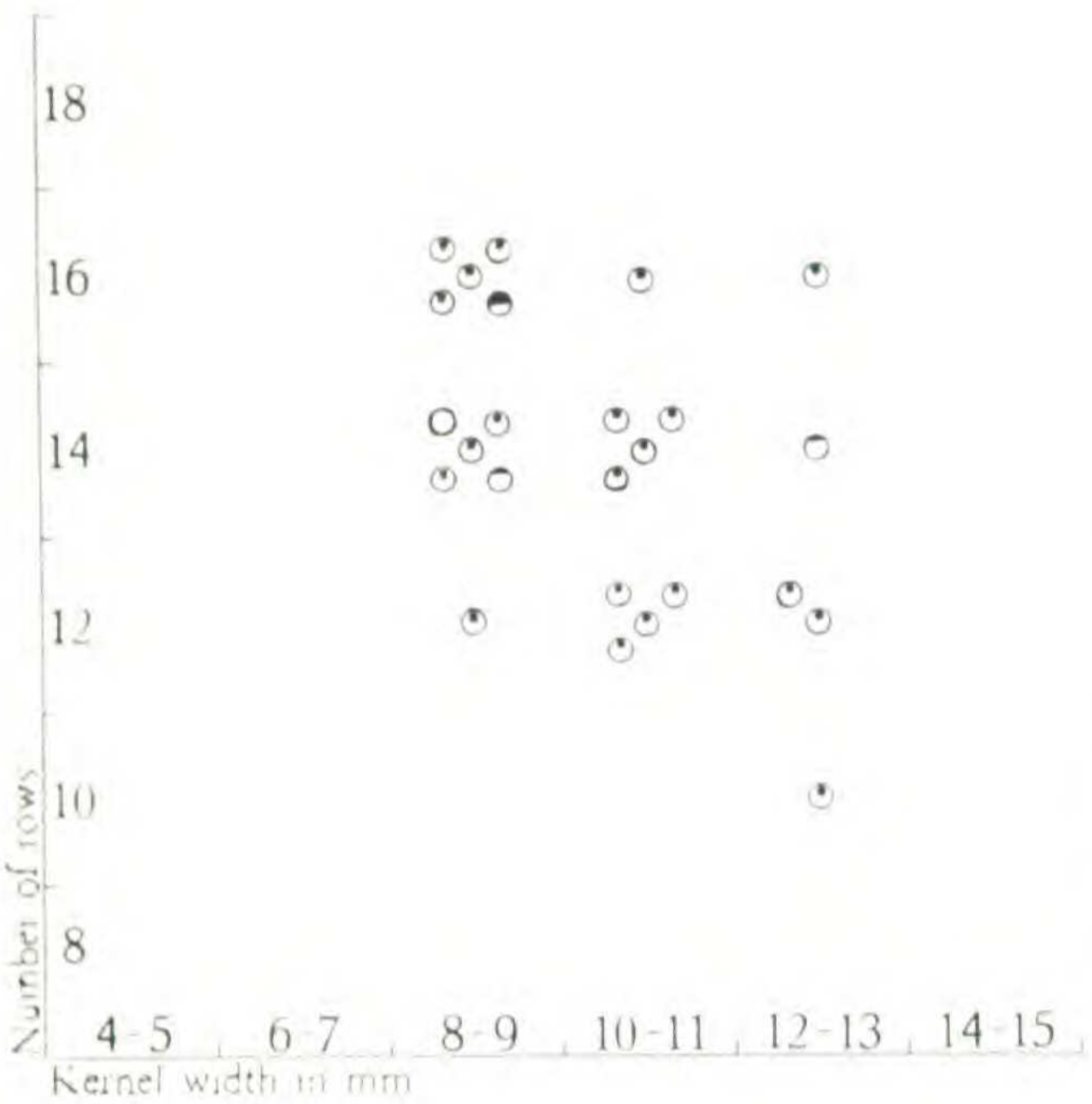
7. Cuidad Vieja



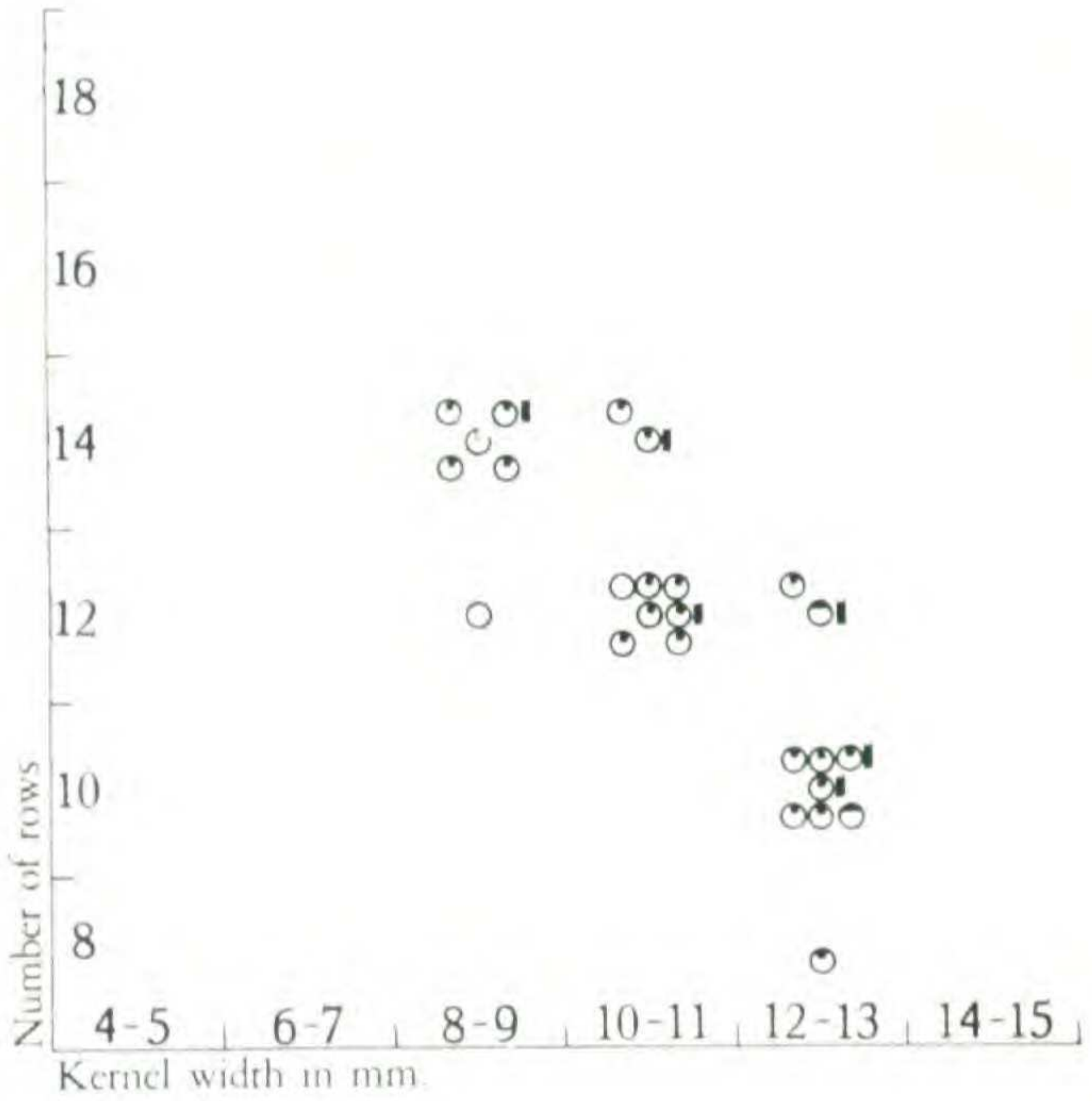
8. Cuidad Vieja

7. Measured at Cuidad Vieja. Thirteen of the ears had purplish cobs, the rest were white. One ear had a few yellow kernels, the remainder were all white. Four ears had a few kernéls with colored aleurone (Pr), and 3 had a faint flush of color in the pericarp.

8. Grown by the same family which grew No. 7 but at another location. White corn, nine of the ears with a few yellow kernels. Seven ears with light purplish cobs, the rest white. Six ears had a few kernels with colored aleurone (Pr) and 2 had a faint flush of color in the pericarp.



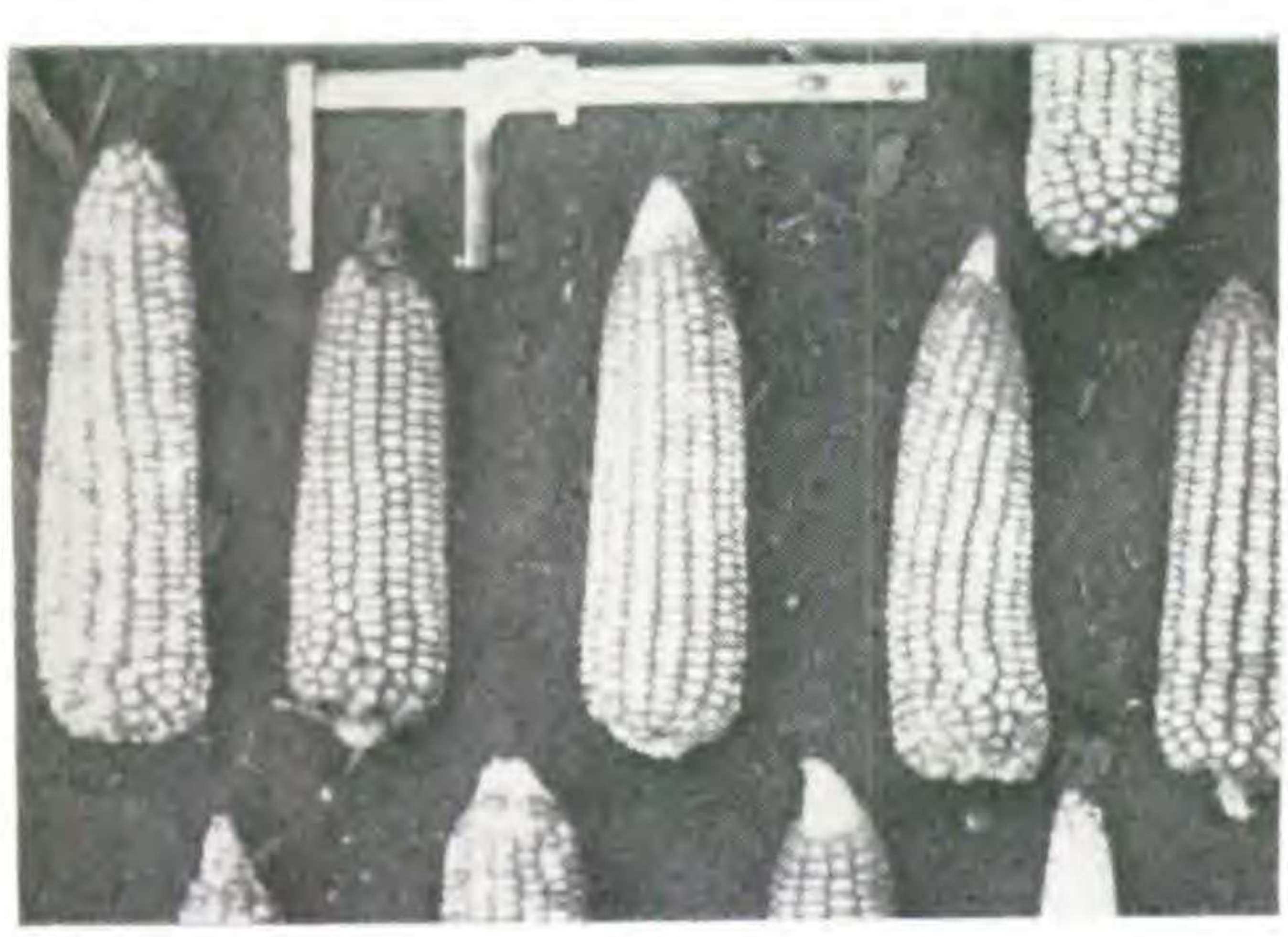
9. Dueñas



10. Santa Lucia

9. Dueñas. All of the ears with white endosperm. Five of the cobs were purplish, the rest were white. Thirteen of the ears had a few kernels with colored aleurone (Pr) while 3 had a faint flush of color in the pericarp.

10. "Maiz haujaqueña", white corn from Santa Lucia above Antigua (see also after No. 10a). Nearly all the ears had a few yellow kernels. Three ears had a single kernel with colored aléuronè (Pr). None were flushed with color in the pericarp, and only one showed faint purplish on the cob. Six ears had been selected for seed (indicated by a bar on the diagram).



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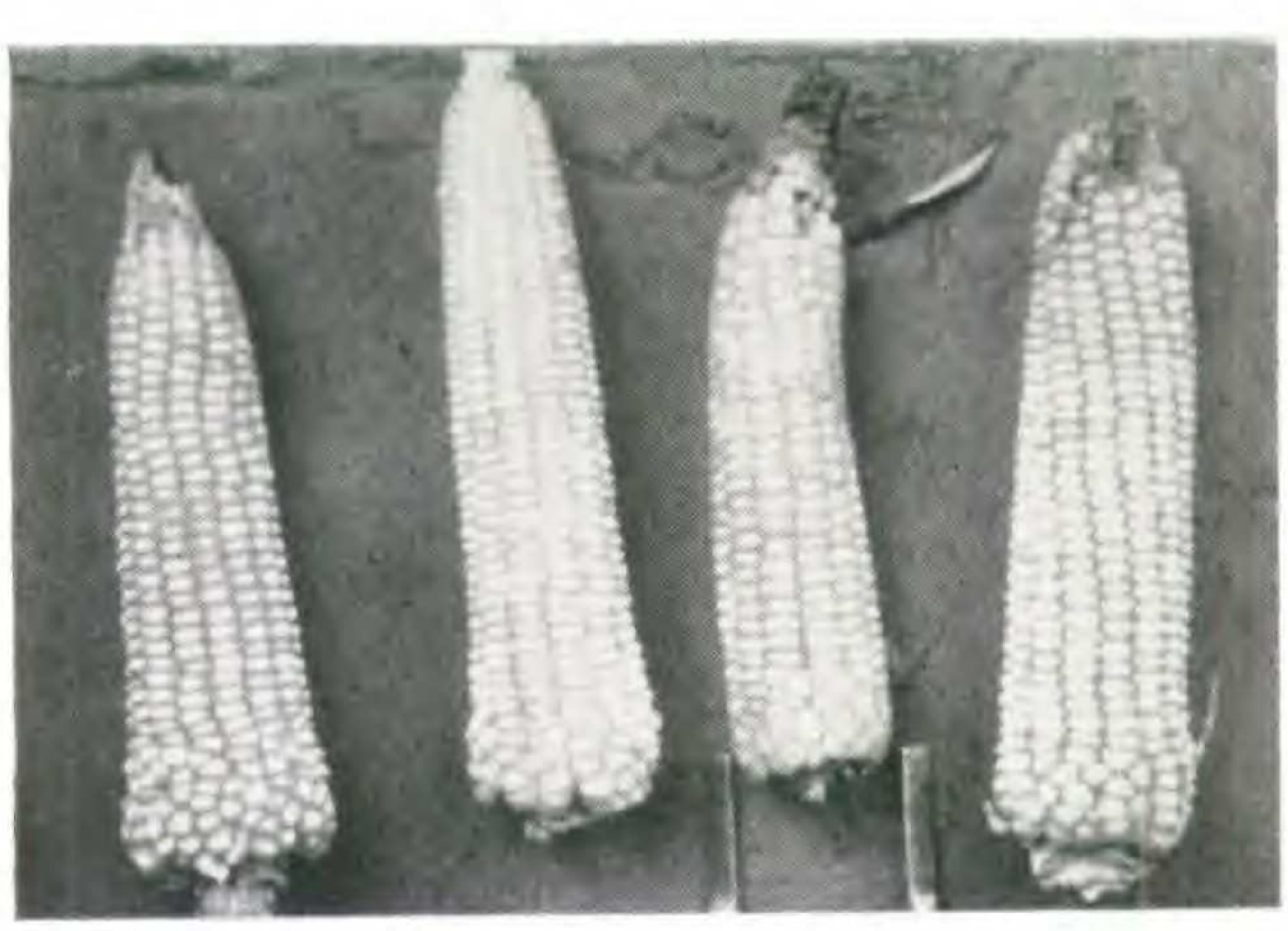

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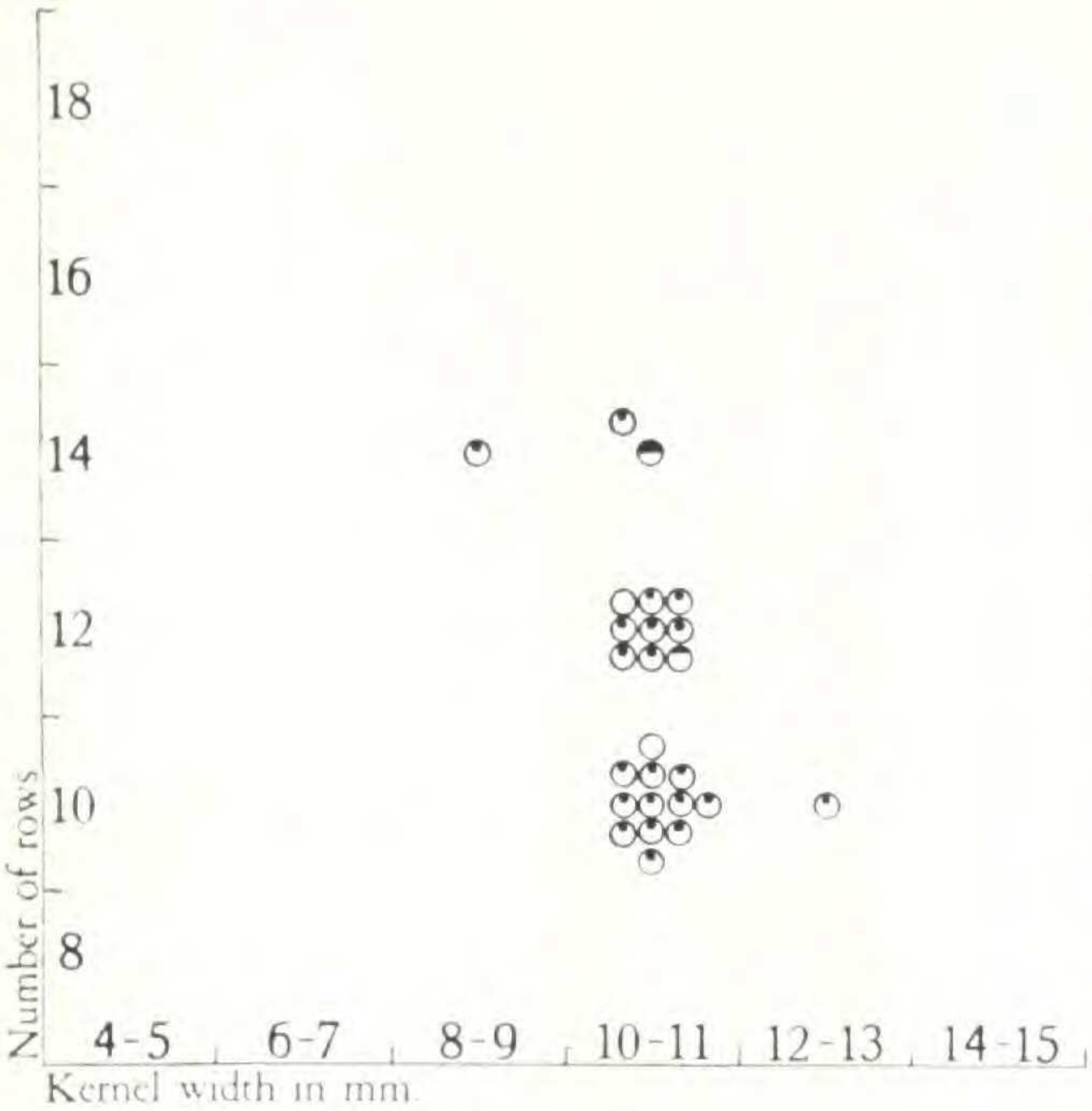


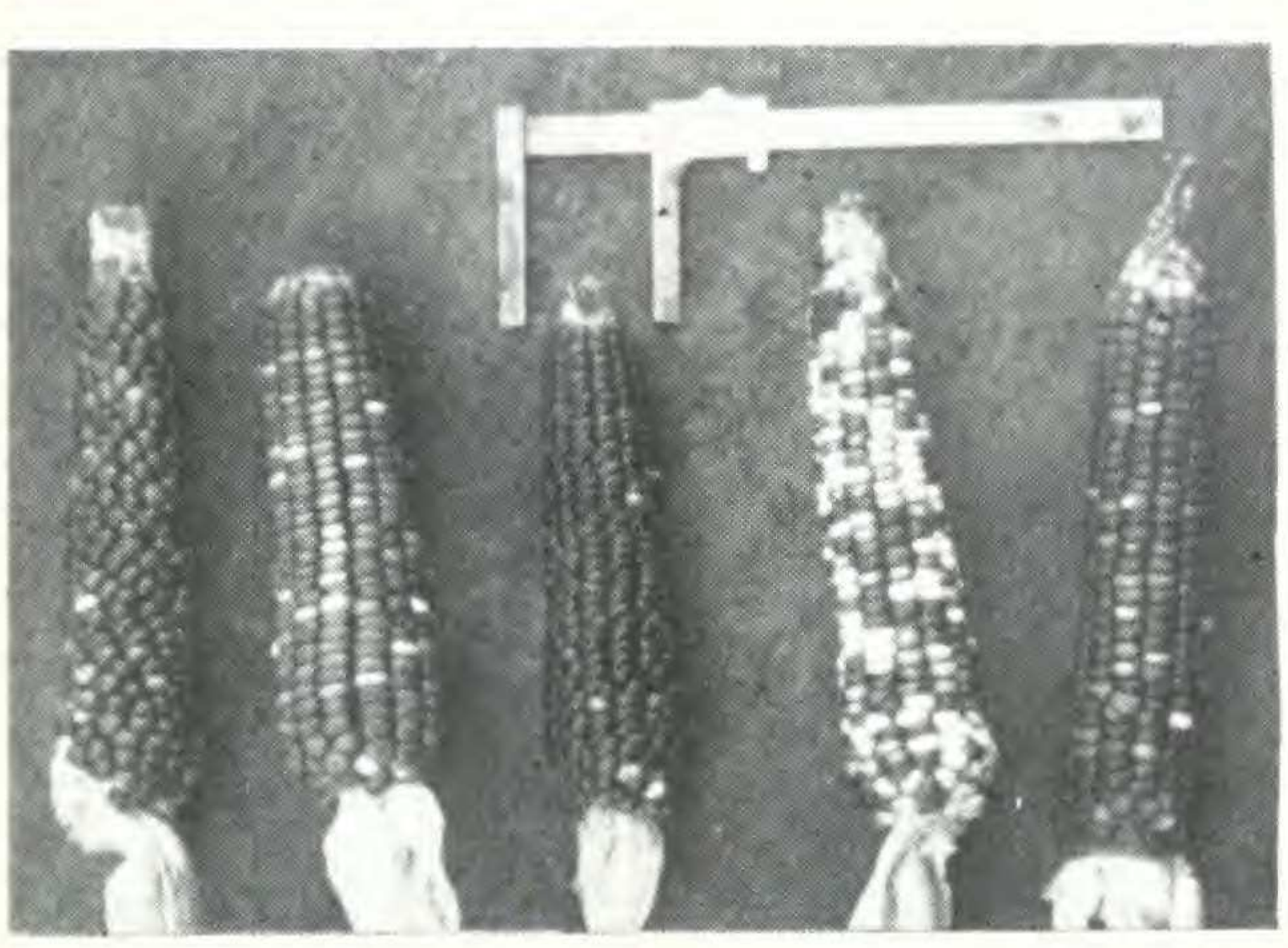
11. Santa Lucia

12. Santa Lucia

11. "Maiz negrito". Santa Lucia. The great majority of the ears had dark blue aleurone (Pr), most of them with an extensive admixture of white kernels. On 4 ears a few kernels had red aleurone (pr). Seven of the ears had some kernels with yellow endosperm, 6 of them had a faint flush of color in their pericarp, and one had a finely variegated pericarp (some allele of P).

12. Yellow corn from the same family. Five ears had faint purplish cobs, the rest being white. All the ears had yellow endosperms, 4 had few to many white kernels. Three had a flush of color in the pericarp, 2 had fine variegation (allele of P). Five ears (marked with a bar) were nubbins ("Mulcos").

(**10a** is a snapshot of the same white corn as No. 10, taken at the open door of the corn crib).



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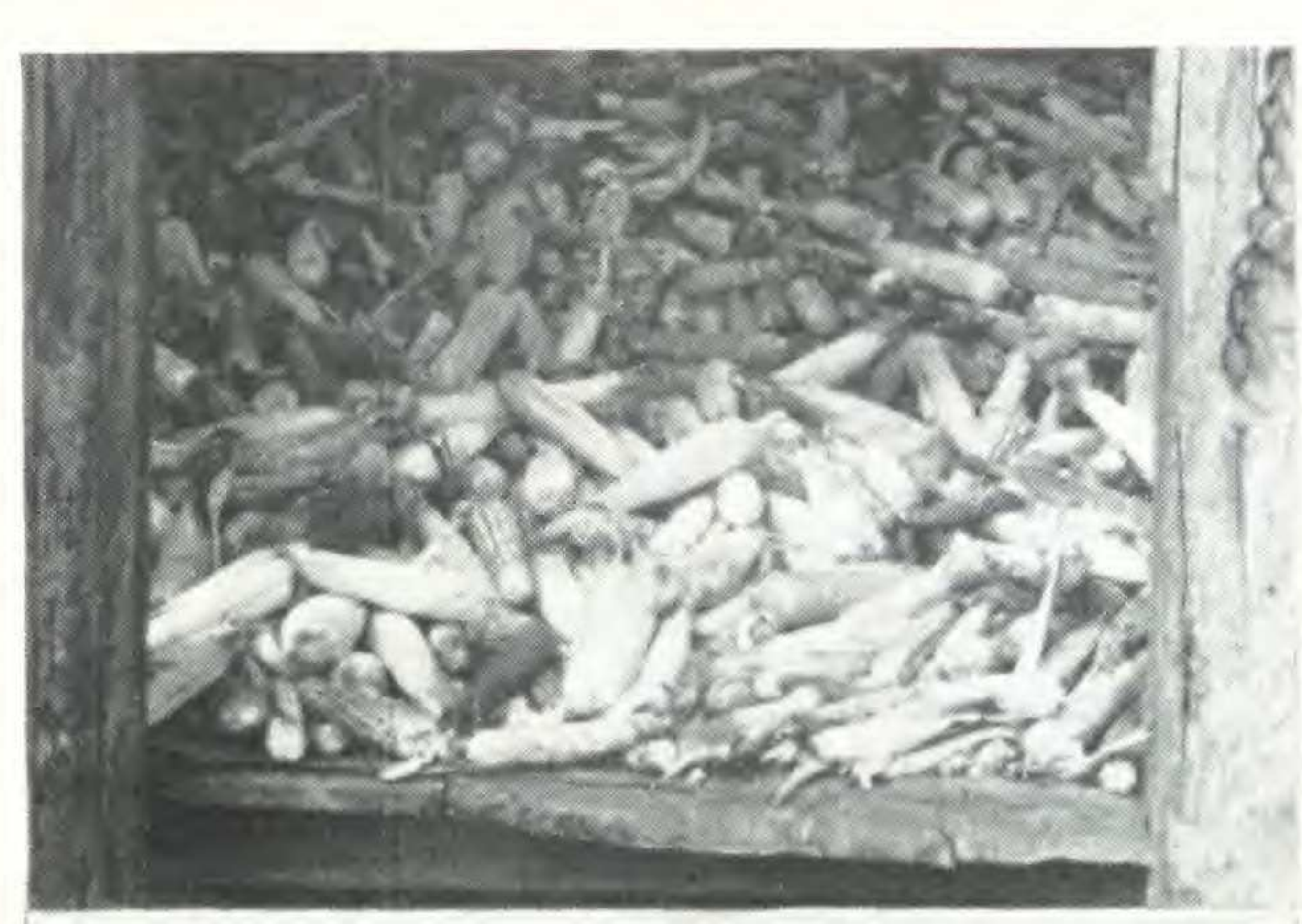
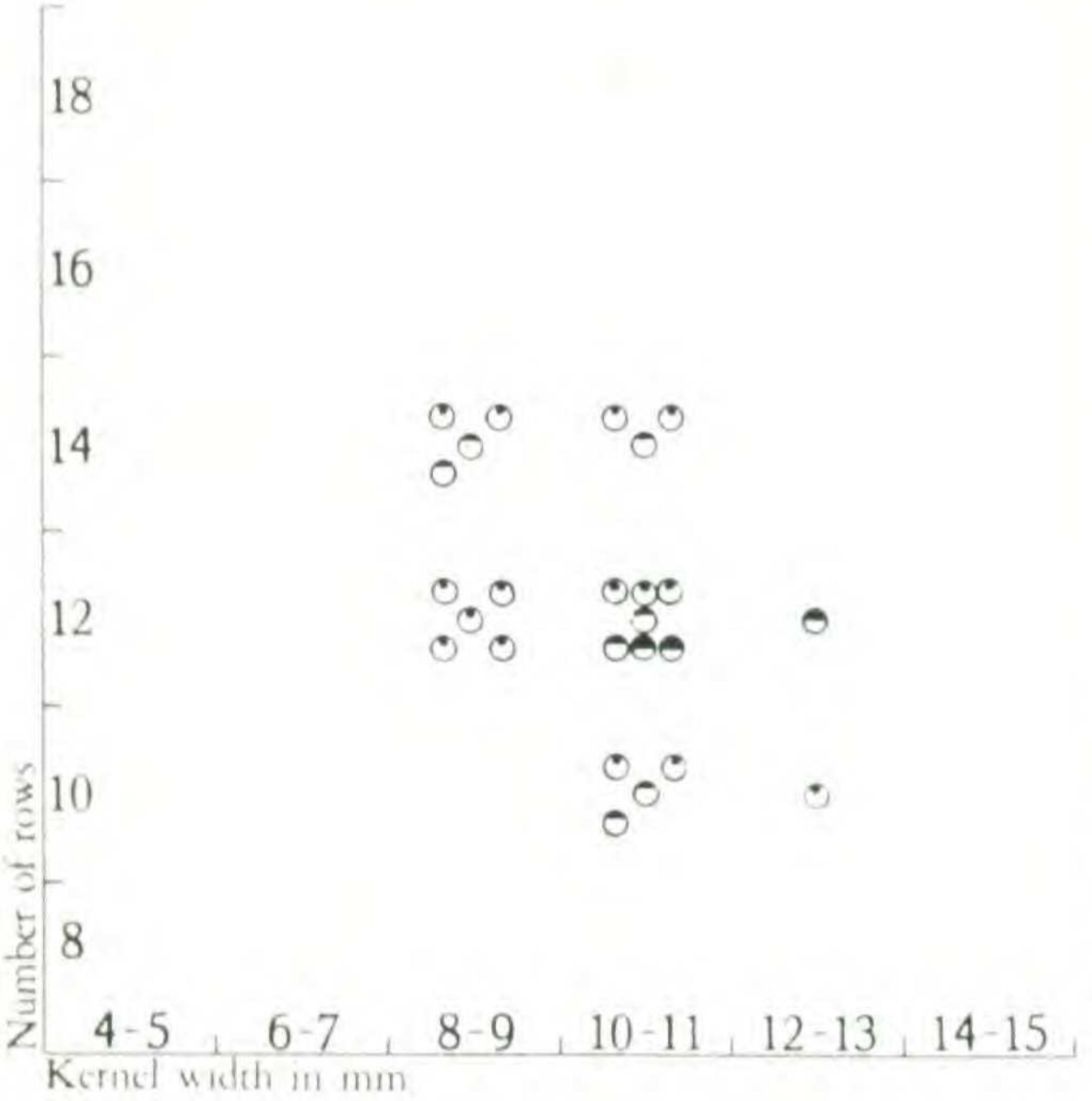
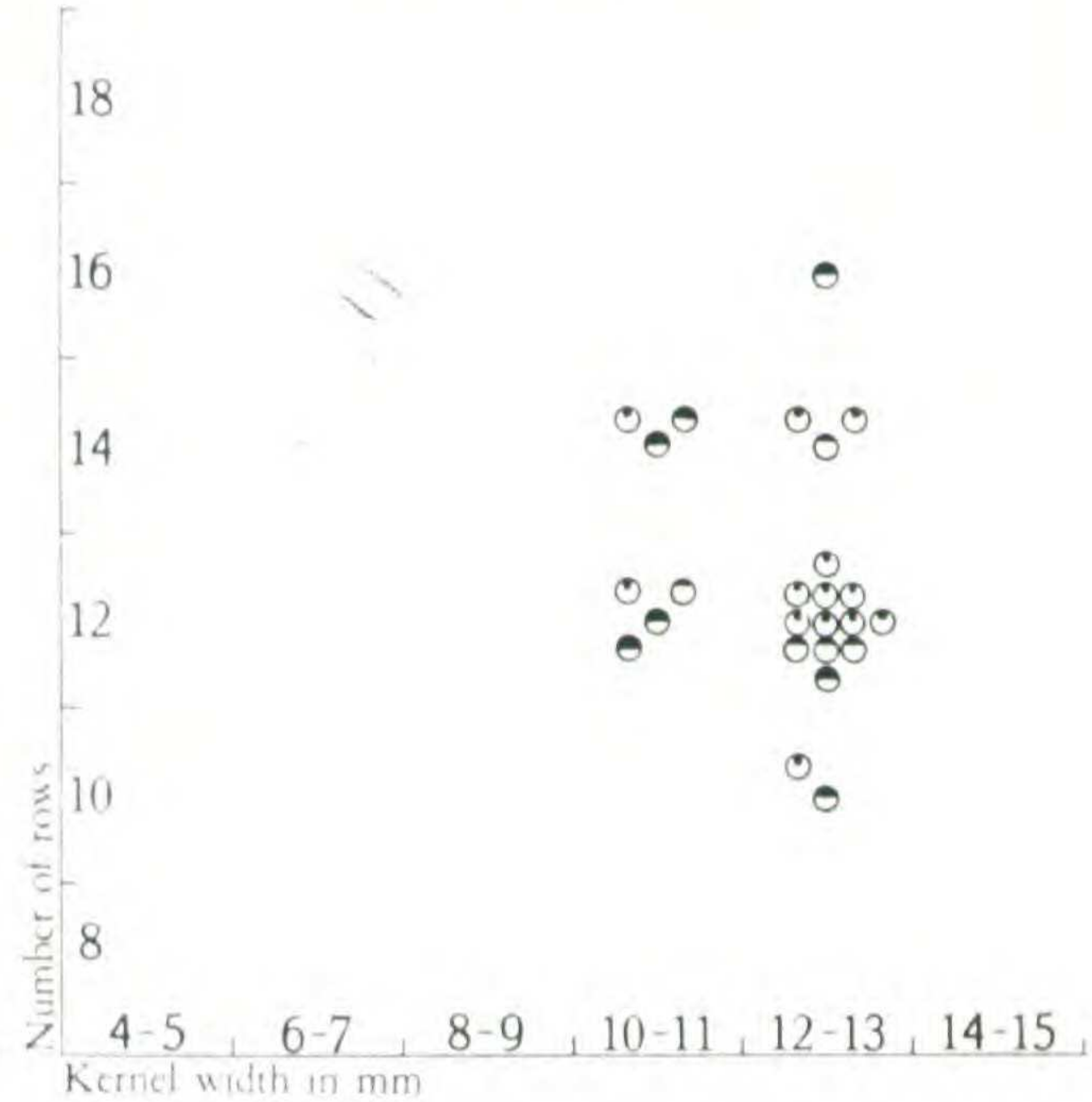


10a



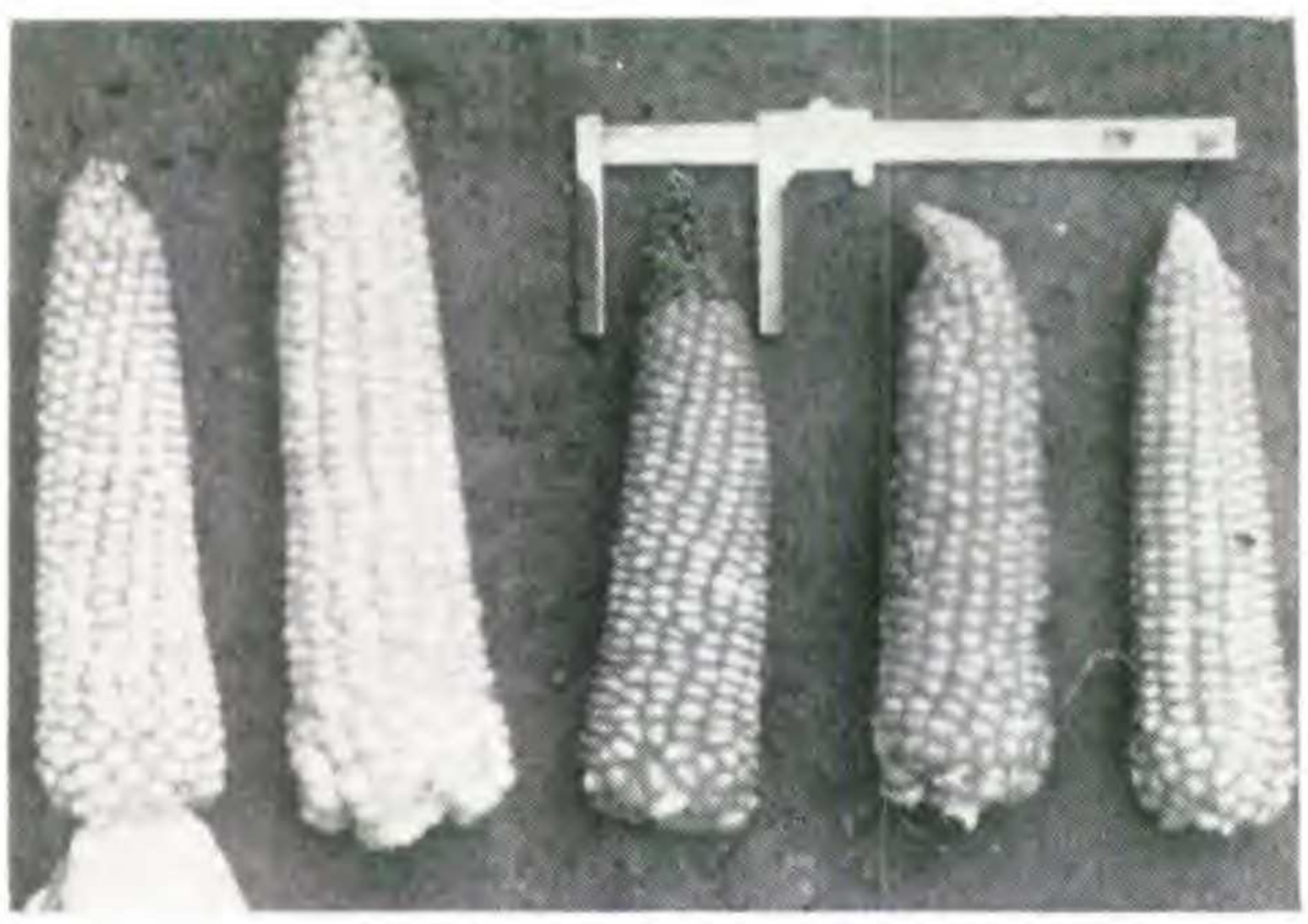
13. San Juan de l'Obispo



14. San Juan de l'Obispo

13. Yellow corn from San Juan de l'Obispo. Some of the ears had a few white kernels, and 4 were segregating for light yellow endosperm. One had a purplish cob; the rest were white. Five of the ears had a few kernels with colored aleurone (Pr), and 4 had a variegated pericarp (allele of P).

14. Blue corn from another family in San Juan de l'Obispo. All but one of the ears had dark blue aleurone, many of them segregating for white. The other ear had red aleurone (pr) as well. Most of the ears had some kernels with yellow endosperm, 7 had a flush of color in the pericarp, and one had variegated pericarp (some allele of P).



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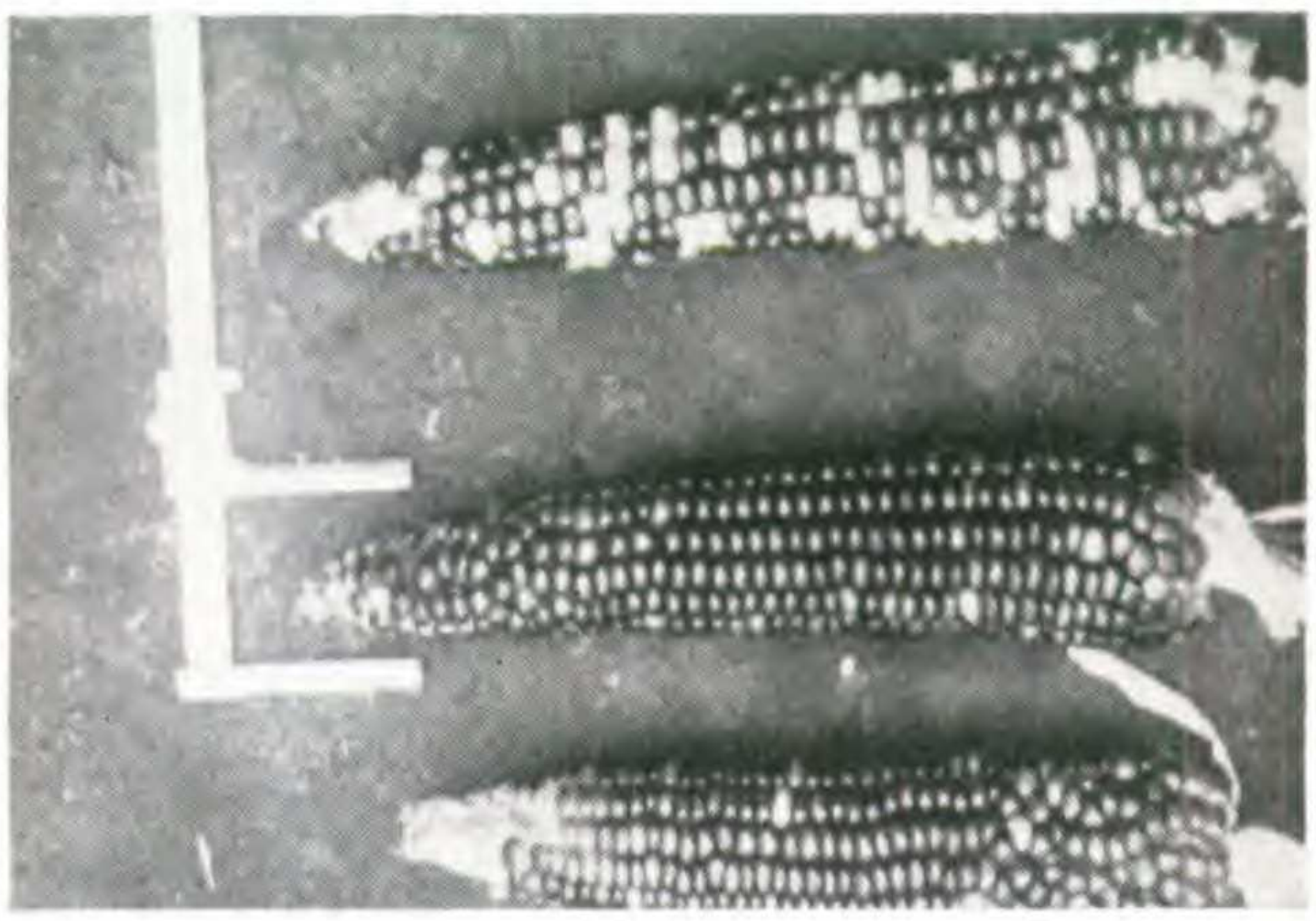

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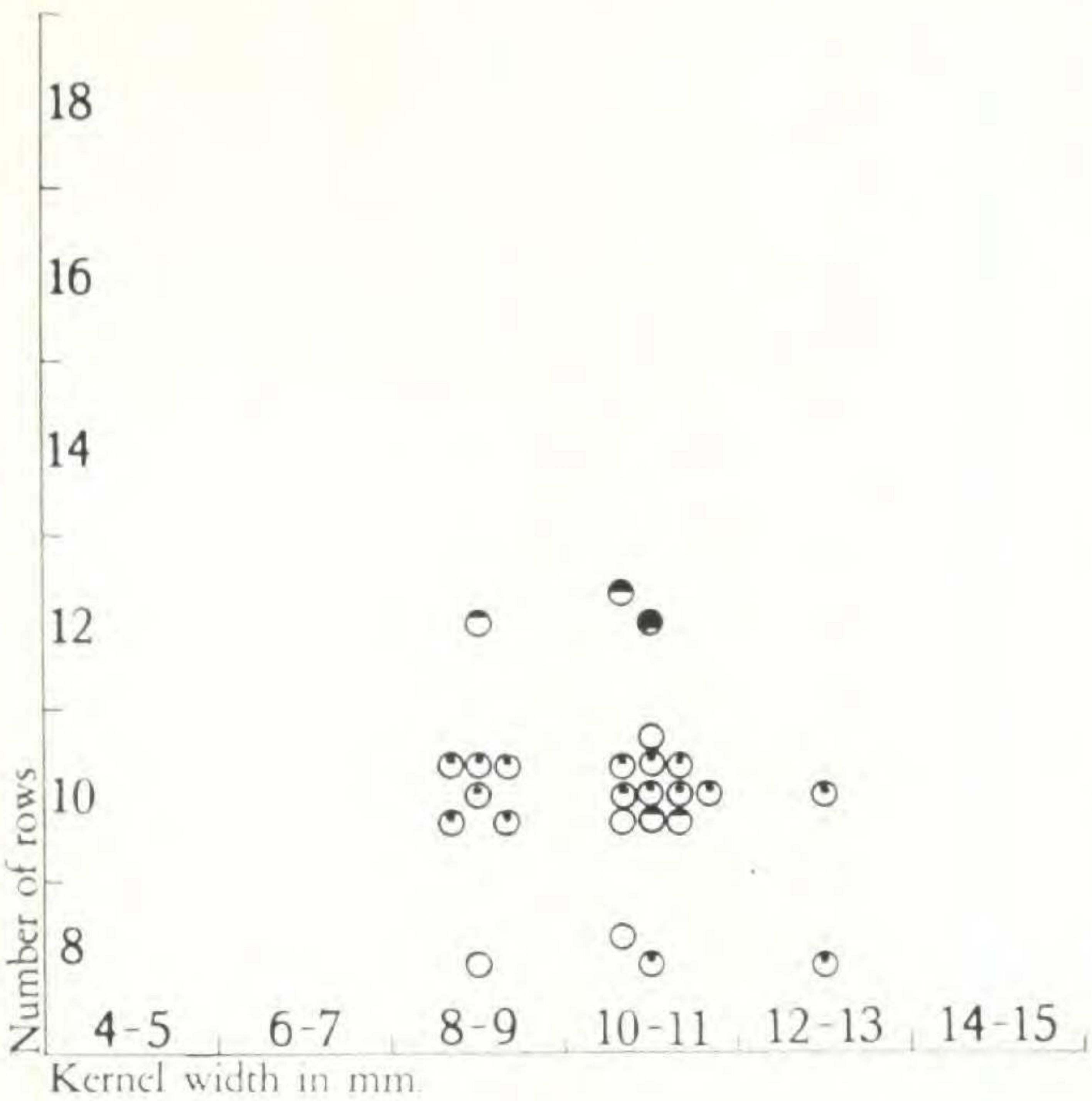
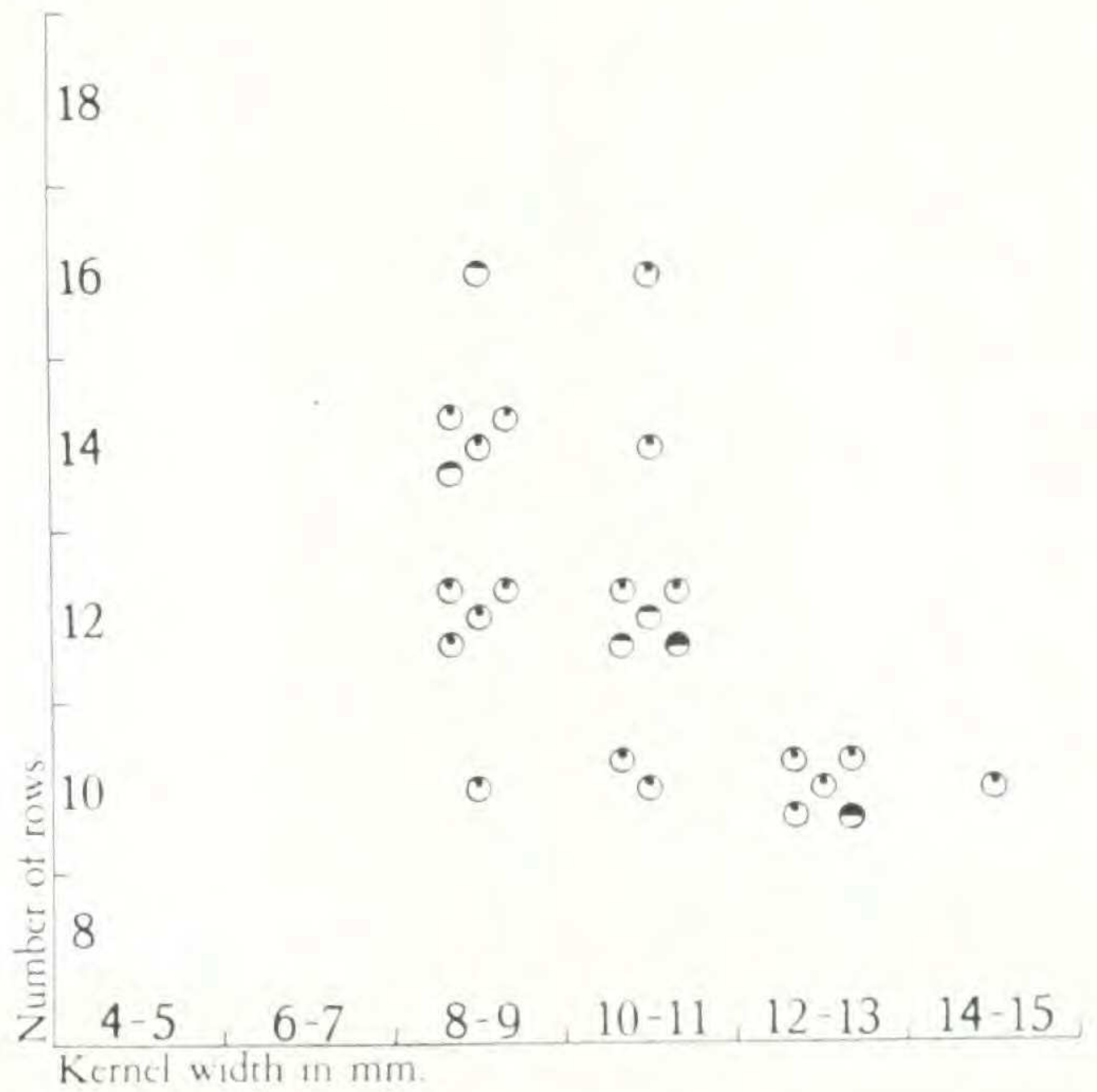


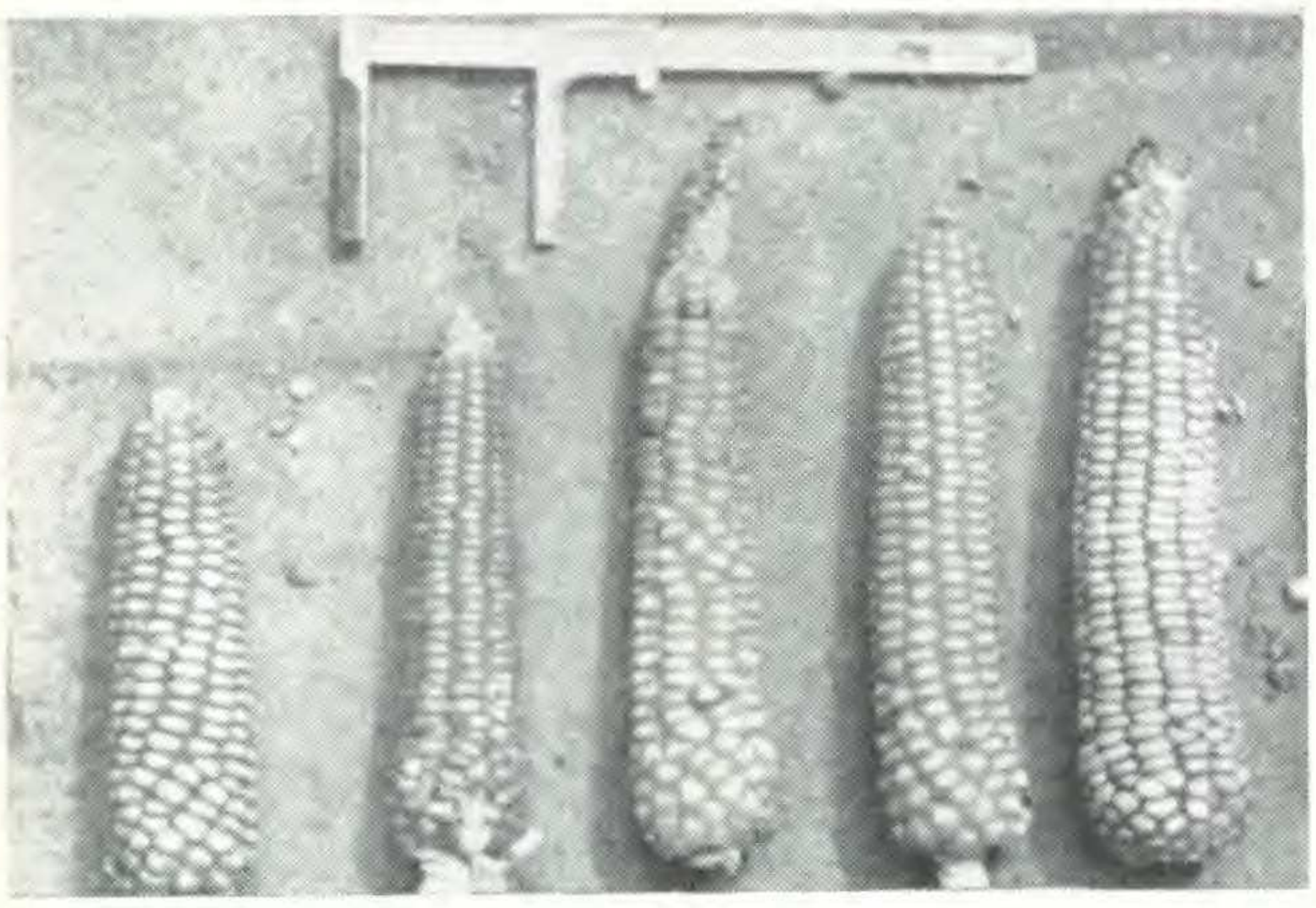
15. San Lucas



16. San Lucas

15. Yellow corn from San Lucas. Most of the cobs were white, 3 being light purple. Nine of the ears had a few kernels with colored aleurone (Pr), 1 had a flush of color in the pericarp, and 2 had red pericarp with a colorless "crown" (P^{cr}).

16. Blue corn from San Lucas. Photographed on the drying floor; not to the same scale as the other photographs. Most of the cobs were white, 2 being pale purple. Most of the ears had a few to many yellow kernels, 7 had a flush of color in the pericarp, and 1 ear had fine stripes of red from some allele of P. All the ears bore colored aleurone (Pr), usually with some white kernels. One ear had red aleurone (pr).



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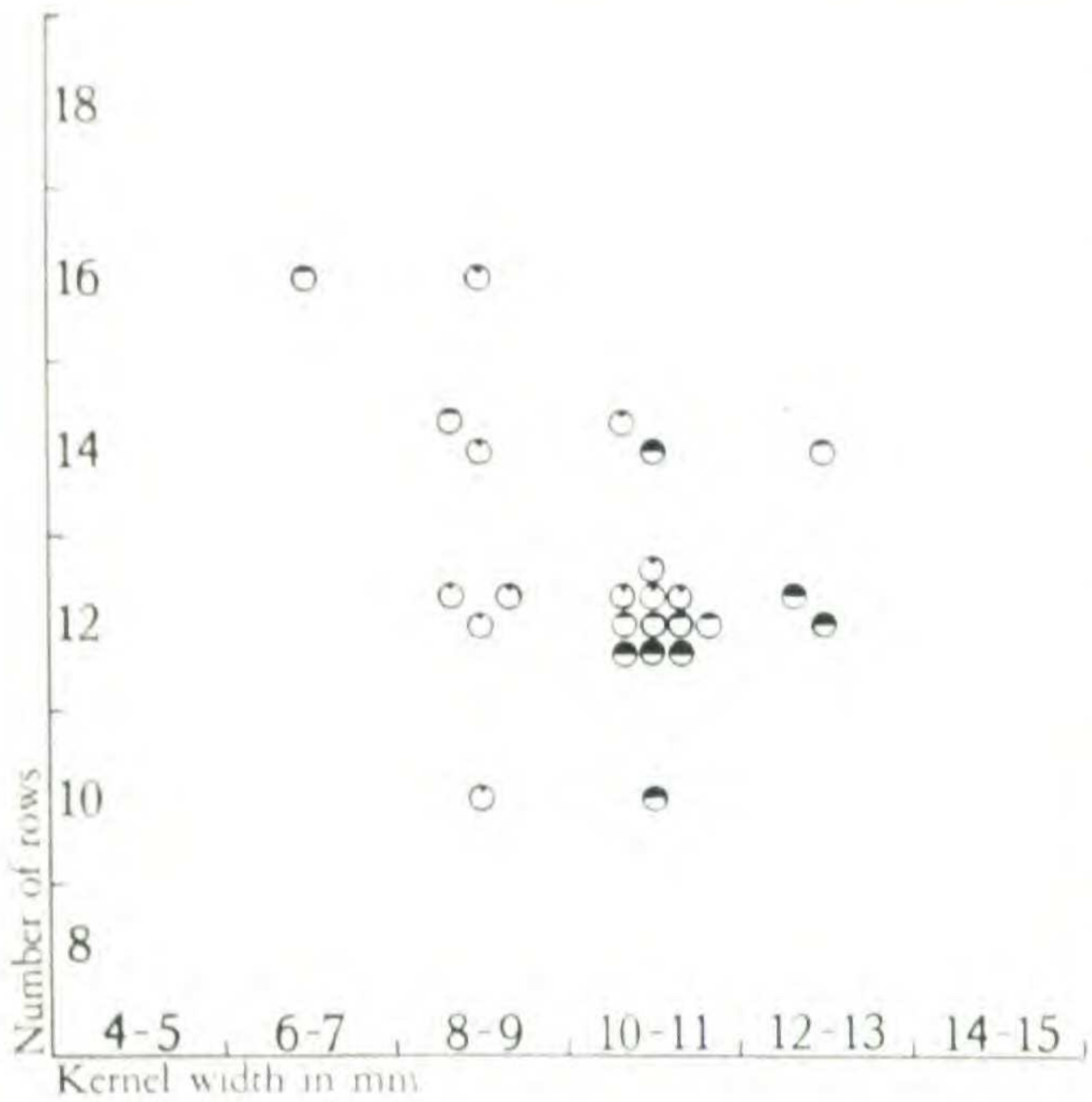
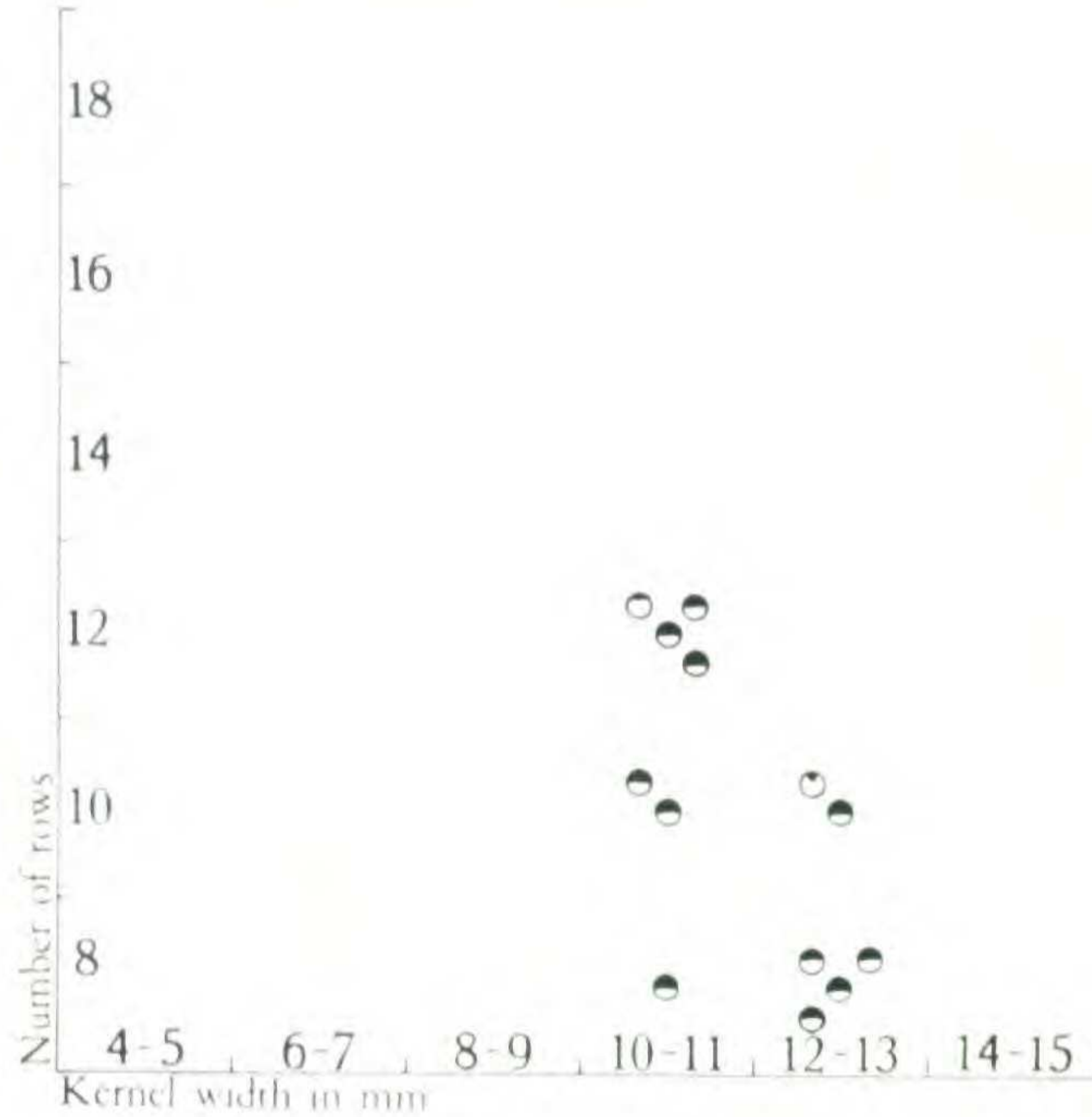


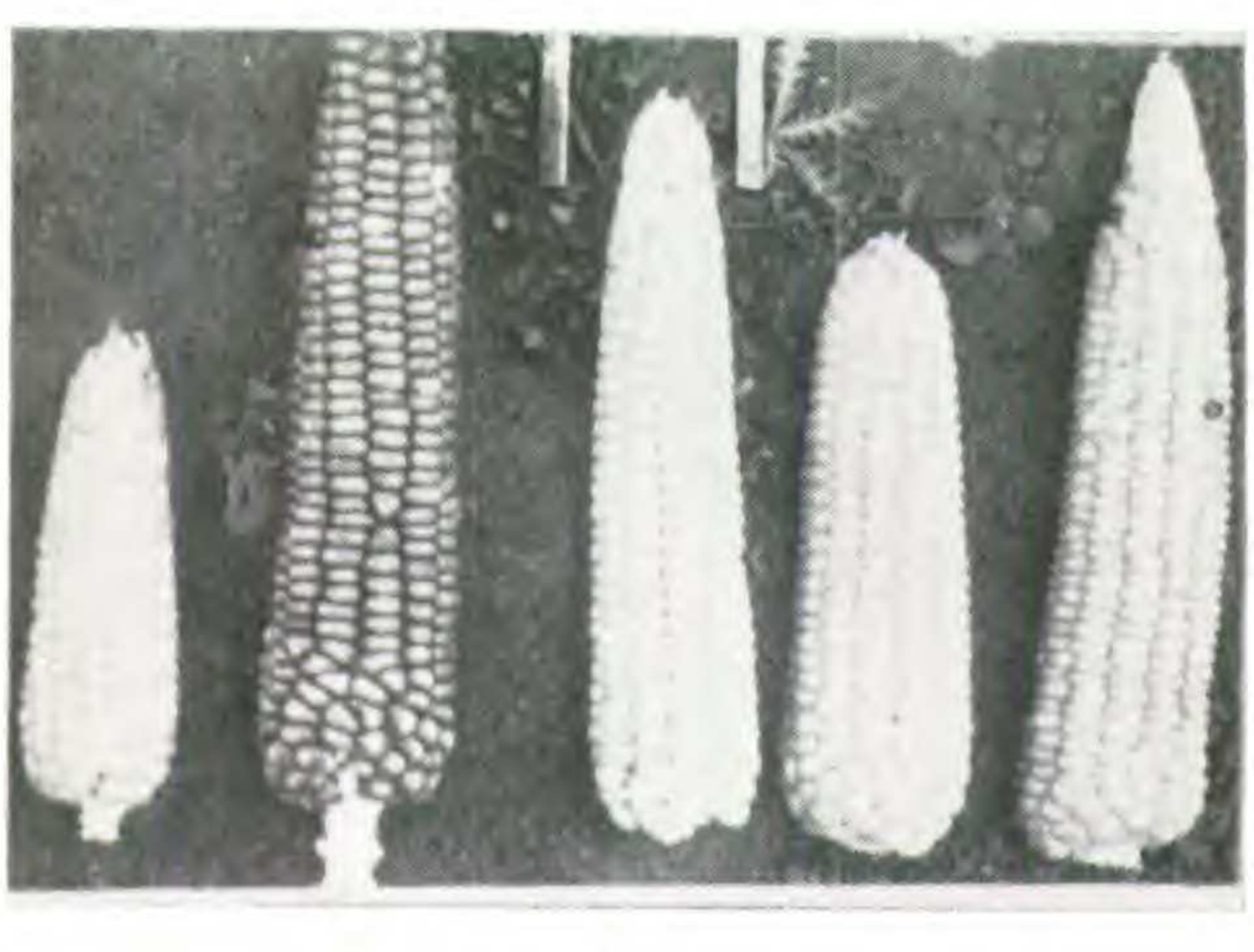
17. Chimaltenango



18. San Miguel Morazón

17. A very mixed yellow corn growing at a third-rate hotel in Chimaltenango. Seven of the ears were segregating for white. The cobs were mostly white, 3 being faint purple, and 2 variegated red and white. Four of the ears had some kernels with colored aleurone (Pr).

18. A distinctive variety from San Miguel Morazón, grown 500 feet above the town itself. Combines a white kernel and low row numbers. Not a random crib sample. All ears with white cobs, 4 with a few yellow kernels, 3 with occasional kernels of colored aleurone (Pr).



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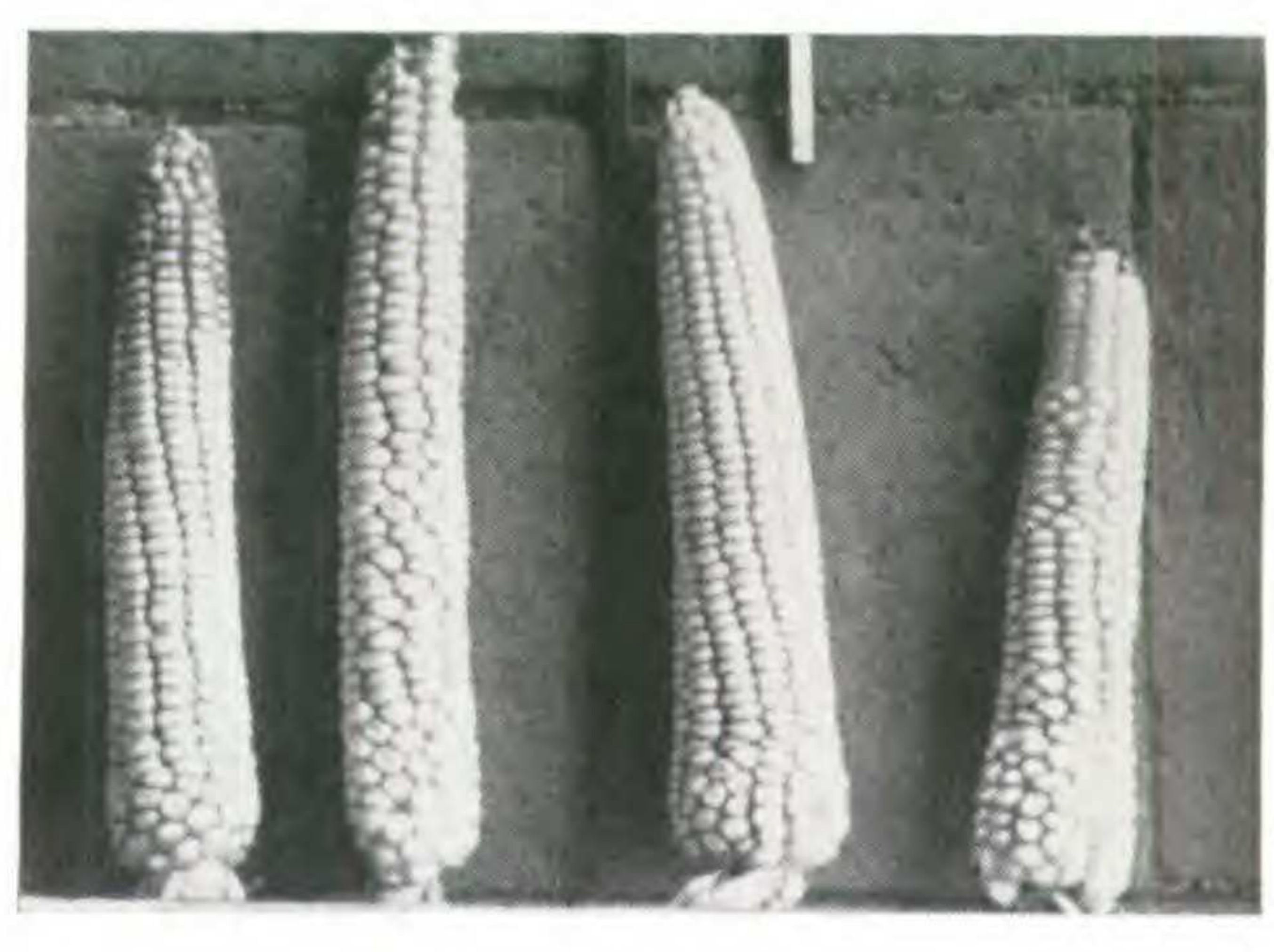

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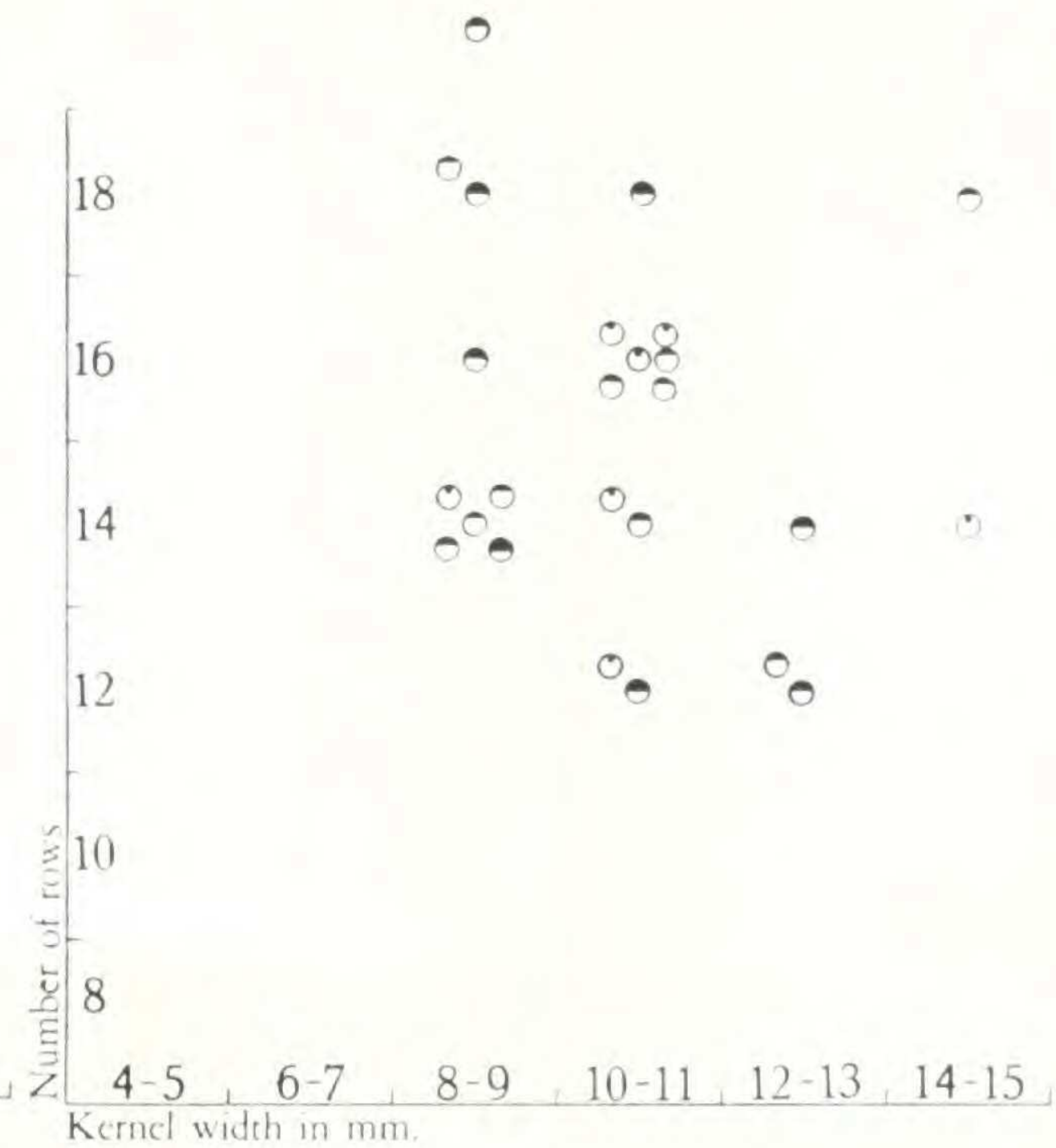
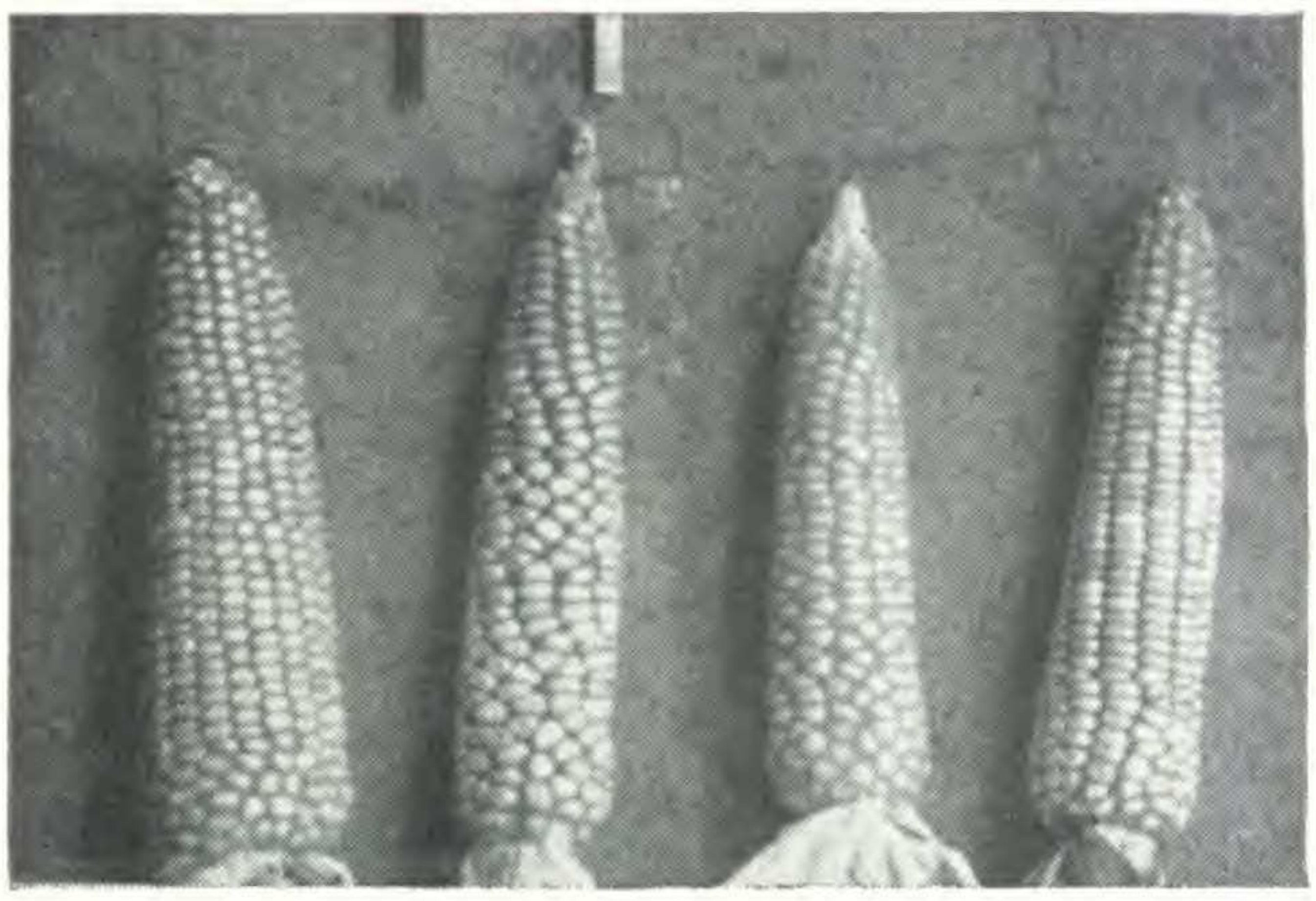
19. Paramos



20. Paramos

19. Yellow corn from near Paramos. Two ears showed a few white kernels, 7 had light purple cobs, 1 had deep purple. This and the next sample represent high-yielding varieties grown by highly skilled growers.

20. Paramos. Yellow corn, 6 ears segregating for white, 1 segregating light and dark yellow. One cob was deep purple, 7 a faint purple, the rest all white. Three ears showed a few kernéls with colored aleurone (Pr).



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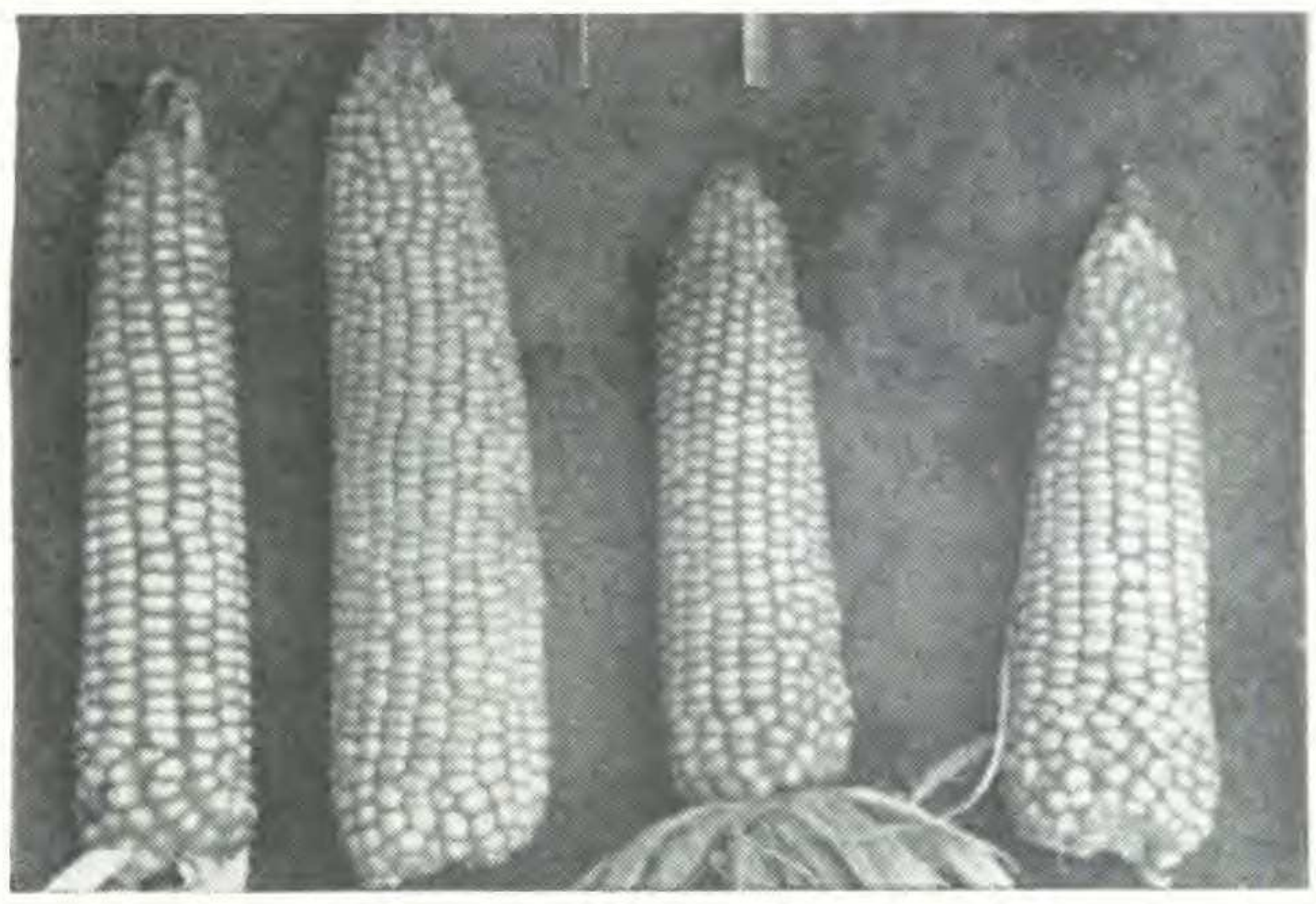

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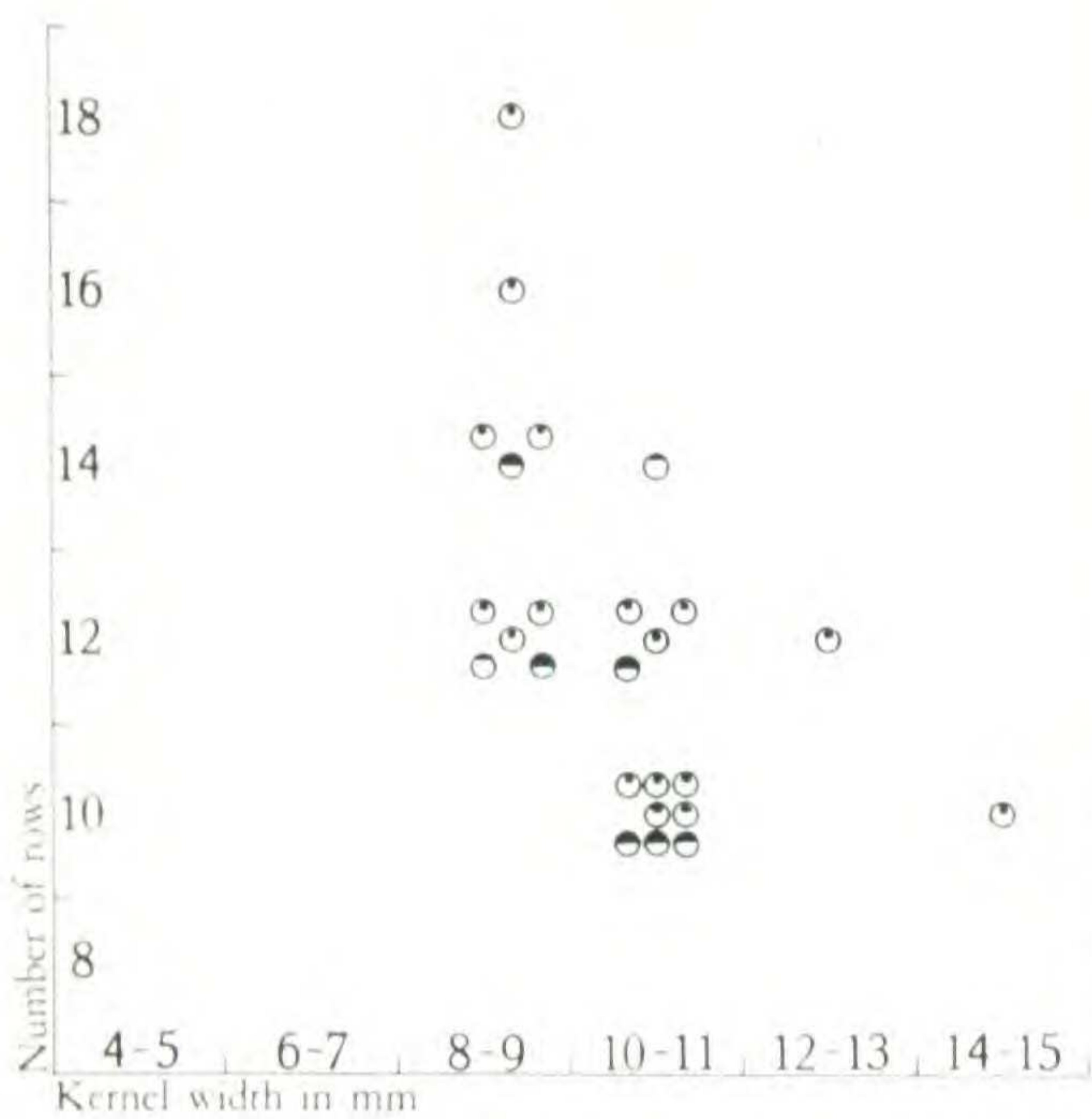
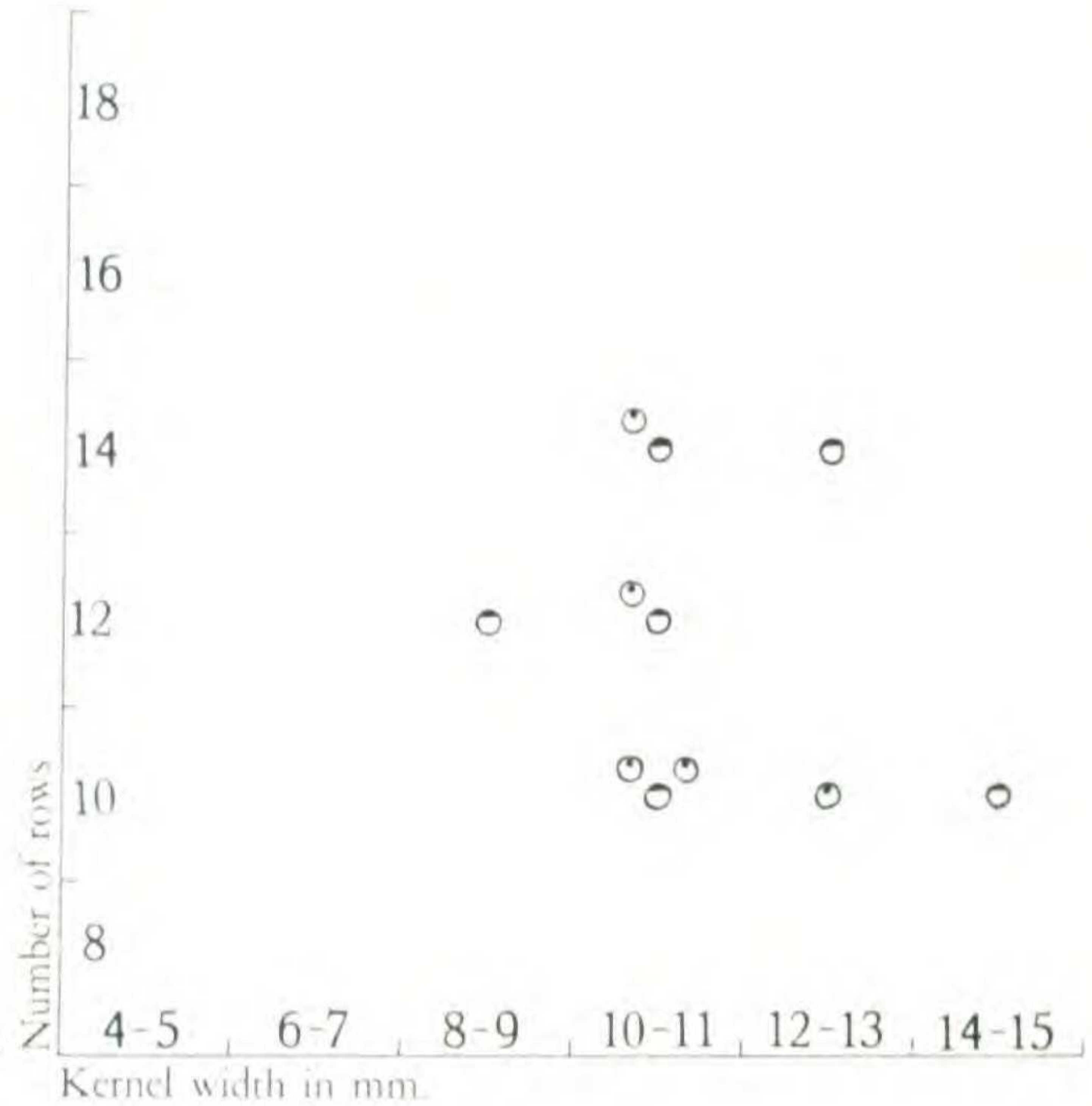


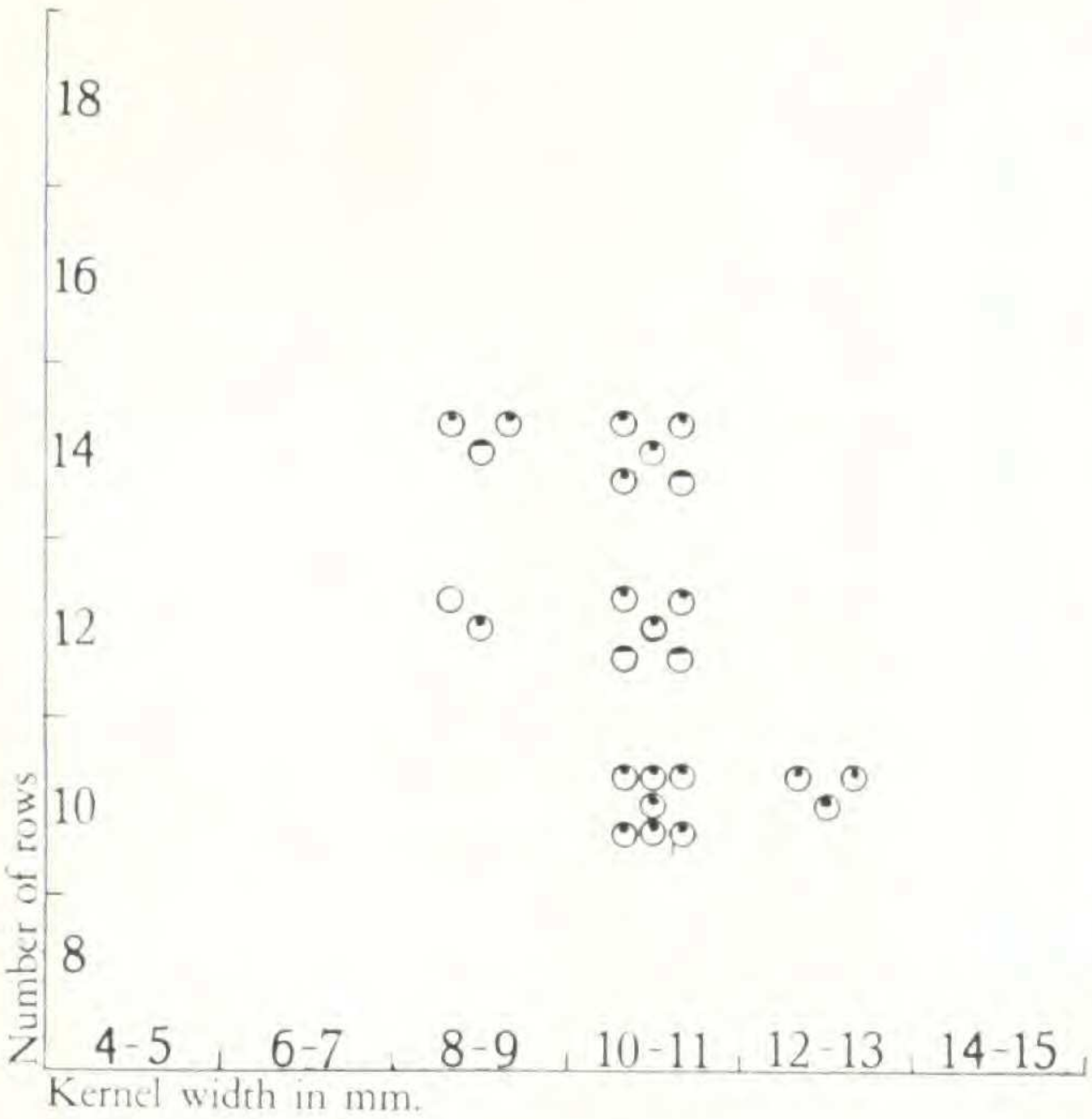
21. Mixco



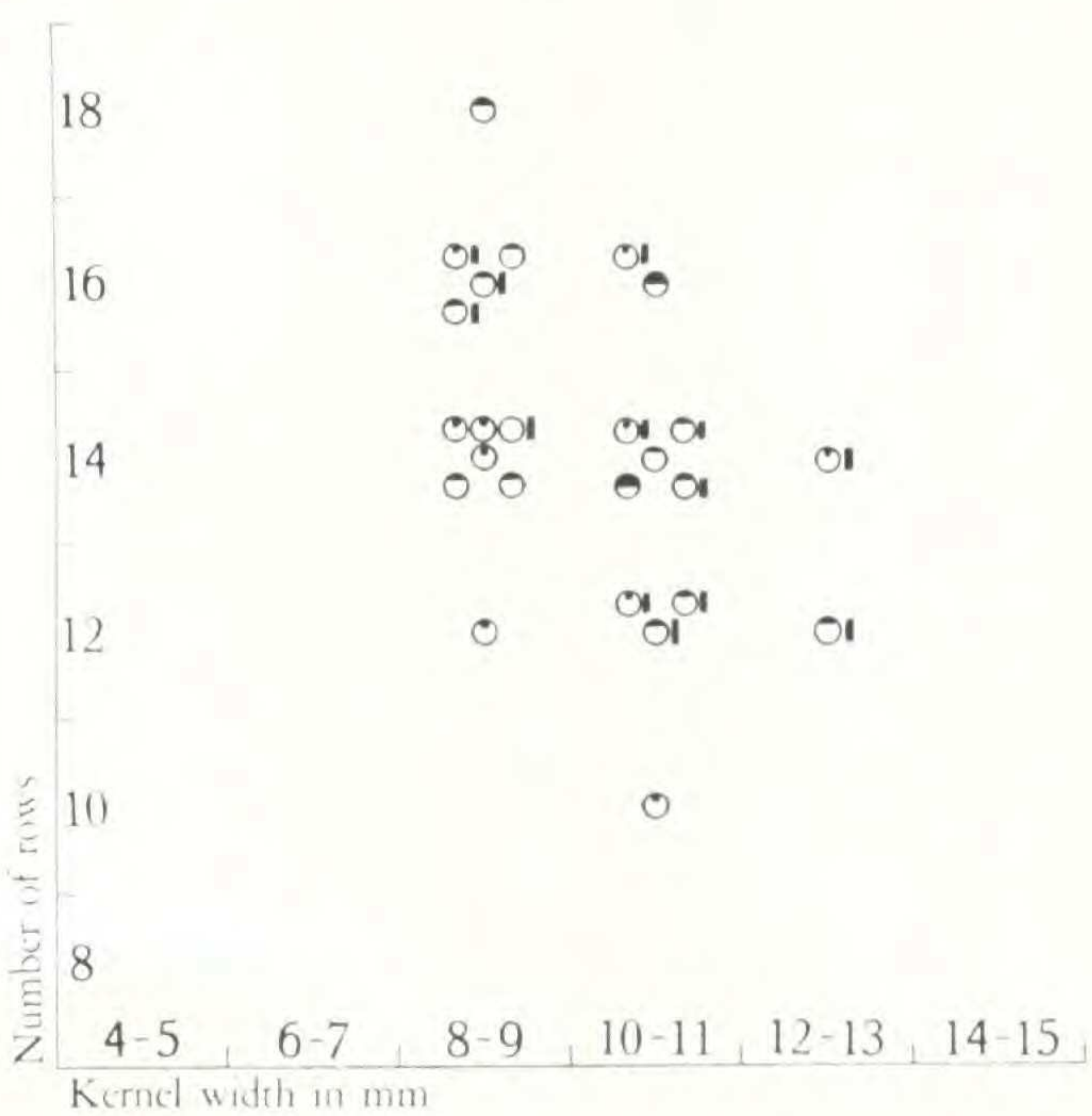
22. High above Zuñil

21. Yellow corn from a small ranch maintained as a show place by a Guatemalan industrialist. Six ears were segregating for white, 4 had a few kernels with colored aleurone (Pr).

22. High above Zuñil. Due to the high altitude and steep-facing north slope, this corn was only partly ripe on December 14. The 11 ears represent all the mature ears in a small field. Six had white cobs, 3 variegated, and 1 light purple. Seven showed variegated pericarp (some allele of P) and 1 had a flush of color. Nearly all the ears showed at least a little multiplication.



23. Above Zuñil



24. Above Zuñil

23. Above Zuñil. Grown half a mile straight down the slope from the 11-ear sample. Just barely ripe December 14. Three had faint purple cobs, the rest were white. All had yellow endosperm. None had colored aleurone, 6 of the ears had a faint flush of color in their pericarp. Though grown by a non Spanish-speaking Indian, the variety was very uniform.

24. White corn, above Zuñil. Grown by an Indian who lived on the same mountainside from which the 2 samples of yellow corn were obtained. Pictures of the corn on the drying floor are shown in text-figs. 3 and 4. Though prevailingly a white variety, good ears with colored pericarp were apparently being included in the seed selection for next year. Twelve of thé ears aré a random sample from the drying floor; the other 13 are from the seed ears which had been set at one side (indicated on the diagram by a bar). Four of the ears had light pink cobs (possibly an allele of P). Ten of the ears showed various alleles of P, (P^{cr}, P, etc.).